In Reply Refer To:
SWR-02-SA-8279:JSS

Mr. James N. Seiber
United States Department of Agriculture
Pacific West Area, Western Regional Research Center
Agricultural Research Service
800 Buchanan Street
Albany, California 94710-1105

Dear Mr. Seiber:

This document transmits the National Marine Fisheries Service's (NOAA Fisheries) biological opinion based on our review of the proposed *Egeria densa* Control Program (EDCP) in the Sacramento-San Joaquin Delta (Delta) in the state of California, and its effects on endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), threatened Central Valley spring-run Chinook salmon (*O. tshawytscha)*, and threatened Central Valley steelhead (*O. mykiss*) in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq*.). Your November 15, 2002, submission of a completed request package for re-initiation of formal consultation was received on November 16, 2002.

This biological opinion (Enclosure 1) is based on information provided during the July 8, 2002, August 1, 2002, and November 19, 2002, meetings between staff from NOAA Fisheries, the United States Department of Agriculture-Agricultural Research Service (USDA-ARS), California Department of Boating and Waterways (DBW), and SePRO Corporation, monthly monitoring reports (July, August, September, and October 2002), a revised Monitoring Plan for the EDCP (November 2002) and an addendum to the 2001 EDCP Environmental Impact Report (March 2003), as well as other sources of information. A complete administrative record of this consultation is on file at the Sacramento, California, field office of NOAA Fisheries.

The biological opinion concludes that the EDCP as proposed by the DBW and permitted by the USDA-ARS is not likely to jeopardize the continued existence of the Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead, nor is it likely to result in the adverse modification of Sacramento River winter-run Chinook salmon critical habitat. Because NOAA Fisheries believes that there will be some incidental take of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon,
and Central Valley steelhead as a result of the project's implementation, an incidental take

statement is also included with the biological opinion. The incidental take statement includes reasonable and prudent measures that NOAA Fisheries believes are necessary and appropriate to reduce, minimize, and monitor project impacts to listed species. Terms and conditions to implement the reasonable and prudent measures are presented in the incidental take statement and must be adhered to in order for the take exemptions of section 7 (o)(2) of the ESA to apply (16 U.S.C. 1536 (o)(2)). The incidental take coverage provided by this biological opinion expires at the end of the 2005 EDCP treatment season.

The biological opinion also provides conservation recommendations for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon and Central Valley steelhead. These include studies designed to explore migration and habitat utilization by salmonids in the Delta, activities to restore and maintain Delta riparian and aquatic habitat, the development of treatment methodologies that avoid or minimize deleterious effects on salmonids, programs to educate the public about the dangers of introduced non-native invasive species, and the promotion of legislation to control the importation and sale of *Egeria* and other invasive species.

Also enclosed are NOAA Fisheries' Essential Fish Habitat (EFH) Conservation Recommendations for Chinook salmon (*Oncorhynchus tshawytscha*), starry flounder (*Platicthys stellatus*), and English sole (*Parophrys vetulus*) as required by the Magnuson-Stevens Fishery Conservation and Management Act (MSA) as amended (16 U.S.C. 1801 *et seq*.; Enclosure 2).

The USDA-ARS has a statutory requirement under section 305(b)(4)(B) of the MSA to submit a detailed response in writing to NOAA Fisheries that includes a description of the measures proposed for avoiding, mitigating, or offsetting the impact of the activity on EFH, as required by section 305(b)(4)(B) of the MSA and 50 CFR 600.920 (j) within 30 days. If unable to complete a final response within 30 days of final approval, the USDA-ARS should provide an interim written response within 30 days before submitting its final response.

If you have any questions regarding this response, please contact Jeffrey Stuart in our Sacramento Area Office, 650 Capitol Mall, Suite 8-300, Sacramento, CA 95814. Mr. Stuart may be reached by telephone at (916) 930-3607 or by Fax at (916) 930-3629.

Sincerely,

Rodney R. McInnis
Acting Regional Administrator

Enclosures (2)

cc: NOAA Fisheries-PRD, Long Beach, CA
Stephen A. Meyer, ASAC, NOAA Fisheries, Sacramento, CA
USDA-ARS, Lars Anderson, Weed Science Program, UC-Davis - One Shields Avenue, Davis, CA 95616
DBW, Marcia Carlock, 2000 Evergreen Street, Suite 100, Sacramento, CA 95815
FWS, Justin Ly, 2800 Cottage Way, Suite W-2605, Sacramento, CA 95825
California Regional Water Quality Control Board, Rudy J. Schnagl, 3443 Routier Road, Suite A, Sacramento, CA 95827
DeltaKeeper, Bill Jennings, 3536 Rainier Avenue, Stockton, CA 95204

Enclosure 1

BIOLOGICAL OPINION

AGENCY: U.S. Department of Agriculture, Agricultural Research Service, Pacific West Area, Western Regional Research Center

ACTIVITY: Egeria densa Control Program: 2003 to 2005

CONSULTATION CONDUCTED BY: Southwest Region, National Marine Fisheries Service

DATE ISSUED:

I. CONSULTATION HISTORY

On July 23, 2001, the biological opinion for the 2001 *Egeria densa* Control Program (EDCP) application season was issued by the Southwest Region of National Marine Fisheries Service (NOAA Fisheries). This opinion concluded that the proposed action was not likely to jeopardize the continued existence of the Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), Central Valley spring-run Chinook salmon (*O. tshawytscha*), and the Central Valley steelhead (*O. mykiss*), nor was it likely to result in adverse modification of Sacramento River winter-run Chinook salmon critical habitat.

On May 15, 2002, NOAA Fisheries received a facsimile of a State Water Resources Control Board letter, dated April 23, 2002, acknowledging receipt of a Notice of Intent from the California Department of Boating and Waterways (DBW) to comply with the terms of the statewide National Pollution Discharge Elimination System (NPDES) General Permit Number CAG990003 (General Permit).

On July 3, 2002, the biological opinion for the 2002 *Egeria densa* Control Program (EDCP) was issued by NOAA Fisheries for the 2002 application season. This opinion concluded that the proposed action was not likely to jeopardize the continued existence of the Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and the Central Valley steelhead, nor was it likely to result in adverse modification of Sacramento River winter-run Chinook salmon critical habitat.

On July 10, 2002, Jeff Stuart of NOAA Fisheries communicated with Emily Alejandrino of the Regional Water Quality Control Board-Central Valley Region (Regional Board) in response to the proposed request by the DBW to change their NPDES Individual Permit to an emergency NPDES General Permit for the 2002 EDCP season.

On August 1, 2002, a meeting was held at the DBW offices in Sacramento to discuss various aspects of the EDCP for 2002. Staff from DBW, Dr. Lars Anderson of the U.S. Department of Agriculture-Agricultural Research Service (USDA-ARS), Jeff Stuart of NOAA Fisheries, and Shaun Hyde of SePRO Corporation. Items discussed included earlier start dates for treatment applications, proposed research on the effects of fluridone exposure to the early life stages of Chinook salmon and subsequent smoltification in support of the current year's request for consultation, and monitoring activities.

On August 30, 2002, NOAA Fisheries received a request for reinitiation of formal section 7 consultation for the EDCP from Dr. Lars Anderson, USDA-ARS.

On September 19, 2002, NOAA Fisheries responded to the August 30, 2002 letter requesting re-initiation, indicating that the USDA-ARS had provided insufficient information to reinitiate the consultation.

On October 1, 2002, a meeting was held at the Sacramento offices of the DBW to discuss the information needs for the re-initiation of section 7 consultation as well as the proposed testing of early life stage Chinook salmon by the SePRO Corporation.

On November 14, 2002, Jeffrey Stuart of NOAA Fisheries received email documents detailing the experimental protocols to be used by SePRO for the salt water challenge and early life stage fluridone exposure studies. Comments were e-mailed back to Mr. Shaun Hyde of SePRO on November 15, 2002.

On November 16, 2002, NOAA Fisheries received additional information requested on September 19, 2002 from the USDA-ARS for the re-initiation of formal consultations for the EDCP.

On November 19, 2002, a meeting was held at the Sacramento offices of DBW to discuss the experimental protocols presented by the SePRO corporation and the potential for earlier start dates for the EDCP season.

On December 16, 2002, NOAA Fisheries sent correspondence to the USDA-ARS confirming that the initiation package for re-initiation of the EDCP formal consultation was sufficient.

On March 7, 2003, NOAA Fisheries received an addendum to the EDCP Environmental Impact Report indicating the addition of the herbicide Sonar® PR to the application protocol.

II. DESCRIPTION OF THE PROPOSED ACTION

The USDA-ARS has requested formal section 7 consultation pursuant to the Endangered Species Act (ESA) in order to implement years three through five of a five-year aquatic weed control program within the geographic boundaries of the Sacramento-San Joaquin Delta (Delta). This program will apply different herbicides to the waterways of the Delta to control the non-native invasive plant, *Egeria densa*. The USDA-ARS, in fulfillment of their directive to control and eradicate agricultural pests, has contracted with the DBW to implement the control program and to conduct research activities in association with the EDCP while providing oversight during the program's implementation.

The Egeria densa Task Force, led by the USDA-ARS, proposes to chemically control the growth and spread of *Egeria densa* with the aquatic herbicides Reward® and Sonar®. Furthermore, USDA-ARS anticipates conducting a two-year research study to assess the aquatic herbicide Komeen® for its possible future utilization in the EDCP. The Komeen Research Project will be analyzed under a separate biological opinion or as an amendment to this opinion because sufficient information was not available to allow NOAA Fisheries to complete the consultation on this portion of the EDCP. Should the DBW determine at any point during the five-year program that the EDCP is ineffective, the DBW would recommend to the legislature and appropriate regulatory agencies that EDCP activities cease. However, if the EDCP is effective, the DBW would submit supplemental environmental documentation that supports continuation of the EDCP (DBW 2000a) beyond five years.

A. Project Activities

1. Herbicides and Treatment Sites

The EDCP is a program intended to control the non-native invasive aquatic weed, *Egeria densa* in the Delta. The Federal nexus for this activity is the USDA-ARS, which has the responsibility to conduct research and provide technical input into the control of nuisance weeds and agricultural pests. The DBW is the state lead for this project, with whom the USDA-ARS has contracted to conduct the application of the program. The currently existing EDCP treatment methods available to the DBW to utilize in the Delta include:

- Reward® (active ingredient [a.i.] diquat dibromide [diquat], U.S. Environmental Protection Agency (EPA) Registration Number 10182-404)

- Sonar®, two formulations which have been used:

    1. Sonar® A.S. (aqueous solution of a.i. fluridone, EPA Registration Number 67690-4)
    2. Sonar® SRP ([slow release pellet] granular formulation of a.i. fluridone, EPA Registration Number 67690-3)

- Mechanical Harvesting (to be used for emergency control of infestation [*i.e.*, cases of extreme vegetation overgrowth or blockage of water intakes] only)

A total of 35 sites were selected in 2001 by the DBW to receive the control treatments for *Egeria densa* (DBW 2003). The sites were chosen based on the level of infestation and impacts to navigation in the Delta (see Table 1 [attached]).

For the 2003 application season, DBW intends to add a third formulation of Sonar® to its suite of herbicides:

- Sonar® PR ([precision release] granular formulation of a.i. fluridone, EPA Registration No. 67690-12)

The other two Sonar® formulations are not well suited to flowing water conditions and thus in past years were restricted to ten sites that had lower flows or less tidal influence than the remainder of the sites. The newer formulation of Sonar® PR pellets is better suited to conditions with higher flows and will be used in areas where the efficacy of the older formulations has been limited. DBW intends to use Sonar® PR in six sites (sites #4, #13, #17, #21-22, and #29 in Table 1) that had previously been treated with either Sonar® AS or Sonar® SRP.

In addition to the six sites described above, DBW intends to incorporate Sonar® PR as an alternative to the application of Reward® (*i.e.*, diquat) in any of 25 sites originally specified as Reward® application sites in the 2001 EDCP Environmental Impact Report (EIR) (sites #3, #5, #7, #9-12, #14-16, #18-20, #23-29, and #31-35 in Table 1).

DBW may select to use either Reward® or Sonar® PR at any one of these 25 sites, based on the ambient conditions at that site. Potentially all 25 sites, or 932 acres, could be treated with the Sonar® PR in a given treatment season rather than with Reward®, but this is unlikely given the variability of ambient conditions in the treatment areas. In addition, DBW is considering the sequential use of Reward®, followed by Sonar® PR as an application method in any of these 25 sites as well as in an additional four sites (sites #1-2, #6, and #8 in Table 1) when conditions warrant sequential treatment. Application of the followup Sonar® PR treatment would occur only when the initial Reward® treatment had dissipated to non-detectable levels in the water column, and subsequent regrowth of the *Egeria* had begun. Sonar® PR is most effective during the active growth phase of plants when the pigment carotene is being synthesized.

DBW has not stated in its project description that it intends to utilize a surfactant in the application of either the Sonar® or Reward® herbicide formulations proposed for the EDCP. NOAA Fisheries will base its analysis only on the effects of the EDCP utilizing the herbicides as formulated with the listed active ingredient.

2. Treatment Protocol

The EDCP proposed treatment season extends from March 1 through November 30. Five crews, each consisting of a Specialist and a Technician, would carry out the control program. A Field Supervisor would manage daily operations, and assign spray locations to the crews on a weekly basis. The EDCP has identified 35 treatment sites for treatment during the application season (Table 1), and these sites would be prioritized according to impacts to navigation and the extent of obstruction. Treatment locations would be determined by weather and tidal conditions, the presence of agricultural crops, native vegetation, potable water intakes, and wildlife.

Reward® and Sonar® A.S. will be applied from 19- to 21- foot air boats by subsurface applications through weighted hoses dragged below the water surface. Sonar® SRP and Sonar® PR will be applied to the treatment area with a broadcast spreader system. Each Reward® treatment site can be expected to be treated up to two times per a year. Sonar® will be applied over a six- to eight-week period by split or multiple applications to maintain a target concentration of 10 to 30 parts per billion (ppb) in the water column (per Sonar® label 2001). The total concentration of Sonar® applied will not exceed 150 ppb during an application season. Waste products, including both active and inert chemical ingredients and dead plants, would be left to sink into the substrate or be carried downstream by water flow. DBW operations are expected to result in dissolved oxygen (DO) levels remaining above 5.0 mg/L in open, fast-flowing waters. DBW operations also are expected in waters with DO levels of 3.0 mg/L or lower, particularly in enclosed, shallow, low-flow waters. Applications of herbicides will not be made in waters where the ambient DO is between 3.0 mg/L and 5.0 mg/L. No program chemicals will be discharged under high wind, high water flow or wave action, or other adverse conditions because these actions could result in the dispersion of applied chemicals beyond the intended target area, unintentionally exposing aquatic organisms and habitat to the herbicides.

Within a given treatment site, Reward® applications for the control of Egeria may be applied at 14-day intervals, as needed, to ensure control of missed plants and regrowth. Because only 1/3 to ½ of the water body area may be treated at one time as per Reward® label requirements, sequential spraying of different sections of the larger site are needed to ensure complete coverage of the treatment site.

B. Proposed Conservation Measures

DBW is obliged to follow the California Department of Pesticide Regulation (DPR) procedures for pesticide application, and to file a Notice of Intent (NOI) with the County Agricultural Commissioner of each county where they will be spraying. DBW staff will perform maintenance protocols that will minimize the chance of a potential chemical spill and adopt response plans that have been developed to contain chemical spills on land and in the water in the advent of a spill. In the event of an EDCP chemical herbicide spill, DFG, the County Agricultural Commissioners (CAC), the Regional Board, the

Office of Emergency Services, and if applicable, the California Highway Patrol, County Health Departments, and the County Sheriff's Office will all be notified as needed.

In addition, DBW is required to adhere to the water quality monitoring protocols approved by the Regional Board per the criteria set forth in the NPDES General Permit which expires January 31, 2004. The General Permit does not specify numeric limits for water quality criteria, but rather gives narrative guidelines for dischargers to follow. The General Permit allows for temporary excursions above the numeric criteria listed in the California Toxics Rule (CTR) and EPA water quality criteria, as long as full restoration of water quality and beneficial uses of the receiving waters are returned to pre-treatment levels following completion of the action. However, DBW anticipates following both the EPA aquatic species toxicity limits and drinking water standards that follow:

- Reward® - the maximum labeled rate for water column concentration (i.e., aquatic species toxicity limit) is 370 ppb. The EPA drinking water concentration standard (Maximum Contaminant Level [MCL]) is 20 ppb. The DBW anticipates treating within the labeled rates the day of treatment and returning to EPA criteria within 24 hours after treatment.

- Sonar® - Application rates will be targeted to achieve a water column concentration of 10-40 ppb for a minimum of 45 days for maximum herbicidal efficacy. This concentration is below the drinking water standards set by the EPA of 150 ppb. Currently, there is not an aquatic species toxicity criterion for fluridone.

DBW also has Memoranda of Understanding with regional water agencies outlining additional application restrictions relating to drinking water intakes. Prior to any work within close proximity of drinking water intakes, DBW will develop a protocol for sampling post-treatment chemical residue around the intakes. Currently, label recommendations for Sonar® applications are allowed within ¼ mile of a potable water intake as long as individual applications do not exceed 20 ppb or exceed 150 ppb for the entire treatment season. Reward® concentration can not exceed 20 ppb in drinking water.

As a requirement of the General Permit, the DBW will follow monitoring protocol terms imposed by the Regional Board. The general goals of the monitoring plan are to:

1. Document compliance with the requirements of the General Permit;

2. Support the development, implementation, and effectiveness of the implementation of Best Management Procedures (BMPs);

3. Demonstrate the full recovery of water quality and protection of beneficial uses of the receiving waters following completion of resource or pest management projects;

4. Identify and characterize aquatic pesticide application projects conducted by the DBW; and

5. Monitor all pesticides and application methods used by the DBW.

The monitoring program includes a daily log of site-specific information (*e.g.*, location, wind, chemicals used, location of listed species/species habitat), and pre- and post-treatment measurements of variables such as DO level, water temperature, turbidity, Egeria biomass and fragments, and chemical residues and toxicity. Three times each year, monitoring will be initiated at two sites in each of the four water categories (tidal, slow-moving, fast-flowing, dead-end slough) for each of the chemicals applied. Each chemical used in the EDCP will be subject to water quality and toxicity monitoring at least once each year. Other monitoring protocols relevant to listed salmonid species include recording field observations for any dead fish or native vegetation; visual assessment of water quality and photo documentation of native vegetation pre- and post-chemical control applications. The EDCP technical crew is trained in fish species identification, and recognition of fish habitat in the Delta and associated waterways by the DBW environmental scientist assigned to the program.

C. Action Area

The project action area is the Sacramento-San Joaquin Delta region, an area of approximately 738,000 acres which is interlaced with hundreds of miles of waterways. The Delta is roughly bordered by the cities of Sacramento, Stockton, Tracy, and Pittsburgh. The Delta region also includes the cities of Antioch, Brentwood, Discovery Bay, Isleton, and about 14 unincorporated towns and villages. The Delta extends north to the I Street Bridge in Sacramento, west to the Suisun Marsh Salinity Control Gates near Pittsburgh, south to the junction of Highway 5 and 205 near Tracy, and east to the Port of Stockton (Figure 1 [attached]). Within this region, DBW has designated 35 high priority sites (see Table 1) which encompass nearly 3,000 acres of infested waterways. Of this acreage, DBW proposes to treat 1,733 infested acres, or 56% of the total infested acreage at the 35 high priority sites.

III. STATUS OF THE SPECIES AND CRITICAL HABITAT

The following listed endangered and threatened species and designated critical habitat occur in the action area and may be affected by the proposed EDCP:

Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha)*
Sacramento River winter-run Chinook salmon designated critical habitat
Central Valley spring-run Chinook salmon (*O. tshawytscha*)
Central Valley steelhead (*O. mykiss*)

A. Species Life History, Population Dynamics, and Likelihood of Survival and Recovery

1. <u>Sacramento River Winter-run Chinook Salmon ESU</u>

The Sacramento River winter-run Chinook salmon was formally listed as threatened in November 1990 (55 FR 46515), and was reclassified as endangered under the ESA on January 4, 1994 (59 FR 440). On June 16, 1993 (58 FR 33212), NOAA Fisheries designated critical habitat for the winter-run Chinook salmon. This area was delineated as the Sacramento River from Keswick Dam (RM 302) to Chipps Island (RM 0) at the westward margin of the Sacramento-San Joaquin Delta, including Kimball Island, Winter Island, and Browns Island; all waters from Chipps island westward to the Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and the Carquinez Straits; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Bay north of the San Francisco-Oakland Bay Bridge. In the areas westward from Chipps Island, including San Francisco Bay to the Golden Gate Bridge, north of the San Francisco-Oakland Bay Bridge, this designation includes the estuarine water column and essential foraging habitat and food resources utilized by Sacramento River winter-run Chinook salmon as part of their juvenile outmigration or adult spawning migrations. Within the Sacramento River this includes the river water, river bottom (including gravel for spawning), and adjacent riparian zone used by fry and juveniles for rearing.

The first adult winter-run Chinook salmon migrants appear in the Sacramento-San Joaquin River system during the early winter months (Skinner 1962). Within the Delta, winter-run adults begin to move through the system in early winter (*i.e.*, November-December), with the first upstream adult migrants appearing in the upper Sacramento River during late December (Vogel and Marine 1991). Adult winter-run presence in the upper Sacramento River system peaks during the month of March. The timing of migration may vary somewhat due to changes in river flows, dam operations, and water year type. Spawning occurs primarily from mid-April to mid-August with peak activity occurring in May and June in the river reach between Keswick Dam and the Red Bluff Diversion Dam (RBDD) (Vogel and Marine 1991). The majority of winter-run Chinook salmon spawners are three years old.

Chinook salmon spawning occurs predominately in clean, loose, gravel in swift, relatively shallow riffles or along the margins of deeper runs. The fry begin to emerge from the gravel in late June to early July and continue through October (Fisher 1994), generally at night. After emergence, fry disperse to the margins of their natal stream, seeking out shallow waters with slower currents, finer sediments, and bank cover such as overhanging and submerged vegetation, root wads, and fallen woody debris. When the juvenile salmon reach a length of 50 to 57 mm, they move into deeper water with higher current velocities, but still seek shelter and velocity refugia to minimize energetic expenditures. Emigration of juvenile winter-run Chinook past the RBDD may occur as early as late July or August, but generally peaks in September and can extend into the next spring in dry years (Vogel and Marine 1991). In the mainstems of larger rivers, juveniles tend to migrate along the margins of the river, rather than in the increased velocity found in the thalweg of the channel. When the channel of the river is greater than 9 to 10 feet in depth, the juvenile salmon inhabit the surface waters (Healy and Jordan 1982).

Juvenile winter-run Chinook salmon occur in the Sacramento-San Joaquin Delta from October through early May based on data collected from trawls, beach seines, and salvage records at the State and Federal water projects (DFG 1998). The peak of juvenile arrivals is from January to March. They tend to rear in the freshwater upper delta areas for about the first two months (Kjelson *et al.* 1981, 1982). Maturing Chinook fry and fingerlings prefer to rear further downstream where ambient salinity is up to 1.5 to 2.5 $^{0}/_{00}$ (parts per thousand; Healy 1980, 1982; Levings *et al.* 1986).

Juvenile Chinook salmon forage in shallow areas with protective cover, such as intertidal and subtidal mudflats, marshes, channels and sloughs (McDonald 1960; Dunford 1975). Cladocerans, copepods, amphipods and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson *et al.* 1982; Sommer *et al.* 2001). Shallow water habitats are more productive than the main river channels, supporting higher growth rates, partially due to higher prey consumption rates, as well as favorable environmental temperatures (Sommer *et al.* 2001). Optimal water temperatures for the growth of juvenile Chinook salmon in the Sacramento-San Joaquin Delta are 54 – 57 ^{o}F (Brett 1952). In Suisun and San Pablo Bays water temperatures reach 54^{o} F by February in a typical year. Other portions of the Delta do not reach this temperature until later in the year, often not until after spring runoff has ended.

Juvenile Chinook salmon follow the tidal cycle in their movements within the estuarine habitat, following the rising tide into shallow water habitats from the deeper main channels, and returning to the main channels when the tide recedes (Levy and Northcote 1981; Levings 1982; Healey 1991). As juvenile Chinook salmon increase in length, they tend to school in the surface waters of the main and secondary channels and sloughs, following the tide into shallow water habitats to feed (Allen and Hassler 1986). Kjelson *et al.* (1982) reported that juvenile Chinook salmon also demonstrated a diurnal migration pattern, orienting themselves to nearshore cover and structure during the day, but moving into more open, offshore waters at night. The fish also distributed themselves vertically in relation to ambient light. During the night, juveniles were distributed randomly in the water column, but would school up during the day into the upper 3 meters of the water column. Fry remain in the estuary until they reach a fork length of about 118 mm (*i.e.,* 5 to 10 months of age). Emigration from the delta may begin as early as November and continue through May (Fisher 1994; Myers *et al.* 1998).

Winter-run Chinook salmon are particularly susceptible to extinction due to the limitations of access to suitable spawning grounds and the reduction of their genetic pool to one population (NOAA Fisheries 1997). The winter-run Chinook salmon also has lower fecundity rates than other races of Chinook salmon in the Central Valley (Fisher 1994), averaging 1000 to 2000 eggs less per female than the other runs (3,700 winter-run, 5,800 late-fall, 4,900 spring-run, and 5,500 fall-run). Both environmental and anthropogenic mediated changes to the habitat have led to a substantial decline in the Sacramento River winter-run populations (see Figure 2 [attached]) over the past three decades. However, the past three years have shown a modest, but positive increase in the winter-run Chinook salmon population, based upon escapement estimates.

2. Central Valley Spring-run Chinook Salmon ESU

NOAA Fisheries listed Central Valley spring-run Chinook salmon as threatened on September 16, 1999 (50 FR 50394) Many of the same factors described above that have led to the decline of the Sacramento River winter-run Chinook salmon ESU are also applicable to the Central Valley spring-run ESU, particularly the exclusion from historical spawning grounds found at higher elevations in the watersheds. Historically, spring-run Chinook salmon were abundant throughout the Sacramento and San Joaquin River systems. They constituted the dominant run of salmon in the San Joaquin River system prior to being extirpated by the construction of low elevation dams on the main tributaries of the watershed. Spring-run Chinook salmon typically spawned in higher elevation watersheds such as the San Joaquin, American, Yuba, Feather, Sacramento, McCloud and Pit Rivers. Currently, spring-run Chinook salmon cannot access most of their historical spawning and rearing grounds in the Central Valley due to the construction of impassable dams in the lower portions of the Central Valley's waterways. Today, the only streams that are considered to harbor naturally spawning wild stocks of spring-run Chinook are Mill, Deer and Butte creeks. All of these creeks are east-side creeks that do not have a major dam or migration barrier. Some additional spawning occurs in the Feather River mainstem and the Sacramento River. However, the genetic characteristics of these fish suggest introgression with both spring-run and fall-run hatchery fish. Elevated water temperatures, agricultural and municipal water diversions, regulated water flows, entrainment into unscreened or poorly functioning screened diversions, and riparian habitat degradation all have negatively impacted the spring-run Chinook salmon ESU.

Adult Central Valley spring-run Chinook salmon migrate into the Sacramento River system between March and July, peaking in May through June. They hold in coldwater streams at approximately 1500 feet above sea level prior to spawning, conserving energy expenditures while their gonadal tissue matures. They spawn from late August through early October, peaking in September (Fisher 1994; Yoshiyama *et al*. 1998). Between 56 to 87% of adult spring-run Chinook salmon that enter the Sacramento River basin to spawn are three years old (Calkins *et al*. 1940; Fisher 1994). Spring-run Chinook salmon fry emerge from the gravel from November to March and spend about 3 to 15 months in freshwater habitats prior to emigrating to the ocean (Kjelson *et al*. 1981). Downstream emigration by juveniles occurs from November to April. Upon reaching the Delta, juvenile spring-run Chinook salmon forage on the same variety of organisms and utilize the same type of habitats as previously described for Sacramento River winter-run Chinook salmon juveniles.

Adult escapement/spawning stock estimates for the past thirty years have shown a highly variable population for the Central Valley spring-run Chinook ESU. Even though the abundance of fish may increase from one year to the next, the overall average population trend has a negative slope during this time period (see Figure 3 [attached]). These variations in annual population levels may result from differences in individual tributary cohort recruitment levels. Central Valley spring-run Chinook salmon, like Sacramento River winter-run Chinook salmon, have a lower fecundity than the larger Central Valley fall and late-fall runs of Chinook salmon. This coupled with the need for cold water to over-summer in while waiting for gonadal tissue to mature, places the Central Valley spring-run Chinook salmon population at a higher risk for population declines than the fall and late-fall runs. Warmer summer water temperatures increase the likelihood of disease and lowered fertility in fish that have to hold in sub-optimal conditions.

3. Central Valley Steelhead ESU

On March 19, 1998, NOAA Fisheries listed the Central Valley steelhead as threatened (63 FR 13347). Historically, Central Valley steelhead once were found throughout the Sacramento and San Joaquin drainages, where waterways were accessible to migrating fish. Steelhead historically were present in the upper San Joaquin River basin, above the current Friant Dam location. Steelhead commonly migrated far up tributaries and into headwater streams where cool, well oxygenated waters are present year-round. Currently, within the Central Valley, viable populations of naturally produced steelhead are found only in the Sacramento River and its tributaries (U.S. Fish and Wildlife Service [FWS] 1998). Wild steelhead populations appear to be restricted to tributaries on the Sacramento River below Keswick Dam, such as Antelope, Deer, and Mill creeks, and in the Yuba River, below Englebright Dam (McEwan and Jackson 1996). At this time, no significant populations of steelhead remain in the San Joaquin River basin (FWS 1998). However, small persistent runs still occur on the Stanislaus River and perhaps the Tuolumne River also. Steelhead are found in the Mokelumne River and Cosumnes River, but may be of hatchery origin. It is possible that other naturally spawning populations exist in other Central Valley streams, but are not detected due to a lack of sufficient monitoring and genetic sampling of rainbow/steelhead resident fish (Interagency Ecological Program [IEP] Steelhead Project Work Team 1999).

Central Valley Steelhead are all considered to be winter-run steelhead (McEwan and Jackson 1996), which are fish that mature in the ocean before entering freshwater on their spawning migrations. Prior to the large scale construction of dams in the 1940s, summer steelhead may have been present in the Sacramento River system (IEP Steelhead Project Work Team 1999). The timing of river entry is often correlated with an increase in river flow, such as occurs during freshets and precipitation events with the associated lowering of ambient water temperatures. The preferred water temperatures for migrating adult steelhead are between 46º and 52º F. Entry into the river system occurs from July through May, with a peak in late September. Spawning can start as early as December, but typically peaks between January and March, and can continue as late as April, depending on water conditions (McEwan and Jackson 1996). Steelhead are capable of spawning more than once (iteroparous) as compared to other salmonids which die after spawning (semelparous). However the percentage of repeat spawning often is low, and is predominated by female fish (Busby *et al.* 1996). Steelhead prefer to spawn in cool, clear streams with suitable gravel size, water depth, and water velocities. Ephemeral streams may be used for spawning if suitable conditions in the headwaters remain during the dry season and are accessible to juvenile fish seeking thermal refuge from excessive temperatures and dewatering in the lower elevation reaches of the natal stream (Barnhart 1986).

In Central Valley streams, fry emergence usually occurs between February and May, but can occur as late as June. After emerging from the gravel, fry migrate to shallow, protected areas associated with the margins of the natal stream (Barnhart 1986). Fry will take up and defend feeding stations in the stream as they mature, and force smaller, less dominant fry to lower quality locations (Shapovalov and Taft 1954). In-stream cover and velocity refugia are essential for the survival of steelhead fry, as is riparian vegetation, which provides overhead cover, shade, and complex habitats. As fry mature, they move into deeper waters in the stream channel, occupying riffles during their first year in fresh water. Larger fish may inhabit pools or deeper runs (Barnhart 1986). Juvenile steelhead feed on a variety of aquatic and terrestrial invertebrates, and may even prey on the fry and juveniles of steelhead, salmon, and other fish species. Steelhead juveniles may take up residence in freshwater habitat for extended periods of time prior to emigrating to the ocean. Optimal water temperatures for fry and juveniles rearing in freshwater is between 45 and 60 ^{o}F. The upper lethal limit for steelhead is approximately 75 ^{o}F (Bjornn and Reiser 1991); temperatures over 70 ^{o}F result in respiratory distress for steelhead due to low dissolved oxygen levels.

Steelhead typically spend one to three years in freshwater before migrating downstream to the ocean. Most Central Valley steelhead will migrate to the ocean after spending two years in freshwater, with the bulk of migration occurring from November to May, although some low levels may occur during all months of the year. The out-migration peaks from April to May on the Stanislaus River whereas the American River has larger smolt-sized fish emigrating from December to February and smaller sized steelhead fry coming through later in the spring (March and April). Feather River steelhead smolts are observed in the river until September, which is believed to be the end of the outmigration period (Calfed Bay Delta Program [CALFED] 2000a).

Over the past 30 years, naturally spawning steelhead populations in the Upper Sacramento River have declined substantially (Figure 4 [attached]). Central Valley steelhead are susceptible to population declines due to the scarcity of cool summer water temperatures required for the survival of juvenile fish in the valley watersheds. Many of these watersheds have been dammed for irrigation and hydroelectricity purposes and block passage to higher elevation waters. Summer water flows for many tributaries are influenced by water diversions to support agriculture. The instream flows are frequently reduced, and the ambient water temperatures in the tailwater sections of the tributaries may exceed the tolerances of juvenile steelhead, thereby causing morbidity and mortality in the fish inhabiting these sections.

B. Habitat Condition and Function

The freshwater habitat of salmon and steelhead in the Sacramento-San Joaquin drainage varies in function depending on location. Spawning areas are located in accessible, upstream reaches of the Sacramento or San Joaquin Rivers and their watersheds where viable spawning gravels and water conditions are found. Spawning habitat condition is strongly affected by water flow and quality, especially temperature, dissolved oxygen, and silt load, all of which can greatly affect the survival of eggs and larvae.

Migratory corridors are downstream of the spawning area and include the Delta. These corridors allow the upstream passage of adults, and the downstream emigration of outmigrant juveniles. Migratory habitat condition is strongly affected by the presence of barriers, which can include dams, unscreened or poorly screened diversions, and degraded water quality.

Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration. Non-natal, intermittent tributaries also may be used for juvenile rearing. Rearing habitat condition is strongly affected by habitat complexity, food supply, or presence of predators of juvenile salmonids. Some complex, productive habitats with floodplains remain in the system (e.g., the lower Cosumnes River, Sacramento River reaches with setback levees [i.e., primarily located upstream of the City of Colusa]). However, the channelized, leveed, and rip-rapped river reaches and sloughs that are common in the Sacramento-San Joaquin Delta typically have low habitat complexity, low abundance of food organisms, and offers little protection from either fish or avian predators.

C. Factors Affecting the Species and Habitat

Sacramento River winter-run, Central Valley spring-run Chinook salmon, and Central Valley steelhead historically all utilized higher elevation watersheds for holding, spawning, and rearing. For example, winter-run Chinook salmon historically spawned in the headwater reaches of the little Sacramento, McCloud and Lower Pit River systems, which had cool, stable temperatures for successful egg incubation over the summer. Populations of winter-run Chinook may have numbered over 200,000 fish (Moyle *et al.*1989; Rectenwald 1989; Yoshiyama *et al.*1998). Construction of Shasta Dam blocked access to all of the winter-run Chinook salmon's historical spawning grounds by 1942. Preservation of a remnant winter-run population was achieved through manipulation of the dam's releases to maintain a cold water habitat in the Sacramento River below the dam as far downstream as Tehama. Other large dams constructed on the natal streams (*e.g.*, the American, Feather and Yuba Rivers) of Central Valley spring-run Chinook salmon and Central Valley steelhead resulted in the loss of access to much of the historical spawning and rearing habitat of these species. Current spawning areas located downstream of dams often are subject to flow and temperature fluctuations and consequent egg and larval mortality resulting from reservoir operation.

Dam construction also has led to alterations in the hydrology of the Sacramento-San Joaquin River system. This has resulted both in reductions in the volume of water flowing through the system and the timing of peak flows that stimulate migratory behavior in both juvenile and adult fish. Currently, less than 40% of historical flows reach San Francisco Bay through the Delta. The reduction in the peak flows has lead to alterations in the cycling of nutrients and changes in the transport of sediment and organic matter, which can lead to distinct alterations in the historical distribution of animal and plant communities upon which the juvenile salmonids depend upon for their forage base and for protective cover. Alterations in flow patterns have also reduced freshwater outflows at the western margins of the Delta. This situation has led to fluctuating salinity levels within the western margin of the Delta and has changed the location and extent of the productive mixing zone between saline and fresh water bodies. Changes in the flushing rate and increased residence time of Delta water has also enhanced the degradative effects of an increased input of contaminants and pollutants to the water system.

Other factors affecting the species and habitat (*e.g.*, levee construction and loss of shallow water habitat, Central Valley Project (CVP) and State Water Project (SWP) operations, invasive species, etc.) are especially pertinent to the Sacramento-San Joaquin Delta (*i.e.*, the action area) and are discussed below under *IV. Environmental Baseline*.

IV. ENVIRONMENTAL BASELINE

The environmental baseline is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species within the action area. The environmental baseline "includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process" (50CFR § 402.02).

A. Physical Habitat Alteration

The action area, the Sacramento-San Joaquin Delta, historically was dominated by freshwater marsh habitat. Nearly 1,400 km^2 of freshwater marsh in the Delta have been diked and drained primarily to create farmland. Industrialization and urbanization reclaimed even more acreage until today only about 6 % of the original 2,200 km^2 area of native wetlands remains (Conomos *et al.* 1985, Wright and Phillips 1988). The original wetlands served as significant foraging areas for numerous species, and enhanced nutrient cycling and retention as well as acting as natural filters to enhance ambient water quality.

A major impact of levee construction has been the conversion of shallow-water habitats that were found along the margins of waterways into deeper rip-rap lined channels. Shallow-water habitats are considered essential foraging habitats for juvenile salmonids, often supporting complex and productive invertebrate assemblages. The substrate that is provided by the stone rip rap is unsuitable for the colonization of native estuarine invertebrate species. Native species (*e.g.*, clams, oligochaetes, chironomids, and amphipods) typically utilize soft substrates for colonization in the estuary rather than hard substrates. Likewise, levee construction has disconnected the rivers and Delta from their historical floodplains. Juvenile salmonids utilize floodplains for foraging and as a refuge from high flow velocities during flood events. Maintenance dredging of the channels can result in increased levels of suspended sediment, the formation of anoxic bottom waters, and increased saltwater intrusion into upstream areas, all of which may cause stress to fish and trigger physiological or behavioral responses.

In the current environmental state of the Delta, juvenile salmonids have been found to use flooded bypasses, such as the Yolo Bypass, as a surrogate floodplain for refuge and off channel rearing (Sommer 2001). Further up the Sacramento River, the Sutter Bypass serves a similar function. The Cosumnes River floodplain, near its confluence with the Mokelumne River, may be the only naturally functioning floodplain left in the Central Valley, and salmonids from this watershed have been consistently found utilizing it during flooding events. In contrast, the dredging of deep shipping channels in the Delta have created situations where the water column becomes hypoxic or even anoxic (*e.g.*, the Stockton Deep Water Ship Channel) and the movement of salmonids through these reaches is interrupted until DO levels return to sustainable levels for the fish. These interruptions to the salmonids' migrations expose the fish to environmental conditions that have negative impacts to the fish's health. Decreases in the viability of gametes in holding adults, and an increase in the susceptibility of the fish to pathogens can be attributed to these delays. Furthermore, extended delays due to low DO and poor water quality in the Delta may lead to increases in salmonid straying rates to spawning grounds outside the adult's natal stream (T. Heyne, DFG, personal communication, February 11, 2003).

B. Water and Sediment Quality

The water quality of the Delta has been negatively impacted over the last 150 years. Increased water temperatures, decreased dissolved oxygen levels, and increased turbidity and contaminant loads have degraded the quality of the aquatic habitat for the rearing and migration of salmonids. The California Water Quality Control Board-Central Valley Regional (Regional Board) in its 1998 Clean Water Act §303(d) list characterized the Delta as an impaired waterbody having elevated levels of chlorpyrifos, DDT, diazinon, electrical conductivity, Group A pesticides (aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexane (including lindane), endosulfan and toxaphene), mercury, low dissolved oxygen (DO), organic enrichment, and unknown toxicities (Regional Board 1998).

In general, water degradation or contamination can lead to either acute toxicity, resulting in death when xenotoxic compound concentrations are sufficiently elevated, or more typically when concentrations are lower, to chronic or sublethal effects that reduce the physical health of the organism to survive over an extended period of time. Mortality may become a secondary effect due to compromised physiology or behavioral changes that lessen the organism's ability to carry out its normal activities. For example, increased levels of heavy metals are detrimental to the health of an organism because they interfere with metabolic functions by inhibiting key enzyme activity in metabolic pathways, decrease neurological function, degrade cardiovascular output, and act as mutagens, teratogens or carcinogens in exposed organisms (Rand 1995; Goyer 1996). For listed species, effects may occur directly to the listed fish or to its prey base, which reduces the forage base available to the listed species.

Sediments can either act as a sink or as a source of contamination depending on hydrological conditions and the type of habitat the sediment occurs in. Sediment provides habitat for many aquatic organisms and is a major repository for many of the more persistent chemicals that are introduced into the surface waters. In the aquatic environment, most anthropogenic chemicals and waste materials including toxic organic and inorganic chemicals eventually accumulate in sediment (Ingersoll 1995).

Direct exposure to contaminated sediments may cause deleterious effects (*e.g.*, lesions, decreased respiratory function, narcosis, tumors, etc.) to listed salmonids. This may occur if a fish swims through a plume of the resuspended sediments or rests on contaminated substrate and absorbs the toxic compounds through one of several routes: dermal contact, ingestion, or uptake across the gills. Elevated contaminant levels may be found in localized "hot spots" where discharge occurs or where river currents deposit sediment loads. Sediment contaminant levels can thus be significantly higher than the overlying water column concentrations (EPA 1994). However, the more likely route of exposure to salmonids is through the food chain, when the fish feed on organisms that are contaminated with toxic compounds. Prey species become contaminated either by feeding on the detritus associated with the sediments or dwelling in the sediment itself. Therefore the degree of exposure to the salmonids depends on their trophic level and the amount of contaminated forage base they consume. Response of salmonids to contaminated sediments is similar to water bourne exposures.

C. Water Operations

Operations of the CVP and SWP pumps in the south Delta have significantly altered water flow patterns in the Delta. When exports are high, water is drawn into the southern portions of the Delta through the Delta Cross Channel, Georgiana Slough and Three Mile Slough from the mainstem of the Sacramento River. Likewise, water flow in the lower San Joaquin River can even be reversed and drawn towards the pumping facilities through the interconnected waterways of the South Delta. Fish are drawn with these altered flow patterns towards the pumping facility. These alterations in water flow have resulted in fish from both the Sacramento River and the San Joaquin River systems being drawn into the South Delta as a result of the water diversions. Lower survival rates are expected due to the longer migration routes, where fish are exposed to increased predation, higher water temperatures, more unscreened water diversions, degraded water quality, reduced availability of food resources, and entrainment into the CVP/SWP export facilities near Clifton Court Forebay in the south Delta (FWS 1990, 1992). Currently, the CVP/SWP pumping facilities are operated to avoid pumping large exports of water during critical migratory or life stage phases of listed fish. Real time monitoring of fish movements, and the development of more efficient fish screens have led to a decrease in the numbers of fish lost to the projects, but entrainment still accounts for significant losses to the listed fish populations. Additionally, Herren and Kawasaki (2001) reported that the Delta region had 2,209 other diversions based upon their field observations. Of these diversions, 90% measured between 12 and 24 inches and only 0.7% had screens on the intakes designed to protect fish from entrainment.

D. Invasive Species

Invasive species greatly impact the growth and survival of juvenile salmonids in the Delta. Non-native predators such as striped bass, largemouth bass, and other sunfish species present an additional risk to the survival of juvenile salmonids migrating through the Delta that was not historically present prior to their introduction. These introduced species are often better suited to the changes that have occurred in the Delta habitat than are the native salmonids. The presence of the Asian clam (*Potamocorbula amurensis)* has led to alterations in the levels of phyto- and zooplankton found in water column samples taken in the Delta. This species of clam efficiently filters out and feeds upon a significant number of these planktonic organisms, thus reducing the populations of potential forage species for juvenile salmonids. Likewise, introductions of invasive plant species such as the water hyacinth and *Egeria densa* have diminished access of juvenile salmonids to critical habitat (Peter Moyle, University of California, Davis, personal communication, April 25, 2002). *Egeria densa* forms thick "walls" along the margins of channels in the Delta. This growth prevents the juvenile salmonids from accessing their preferred shallow water habitat along the channel's edge. In addition, the thick cover of *Egeria* provides excellent habitat for ambush predators, such as sunfish and bass, which can then prey on juvenile salmonids swimming along their margins. Water hyacinth (*Eichhornia crassipes*) creates dense floating mats that can impede river flows and alter the aquatic environment beneath the mats. Dissolved oxygen levels (DO) beneath the mats often drop below sustainable levels for fish due to the increased amount of decaying vegetative matter produced from the overlying mat. Like *Egeria,* water hyacinth is often associated with the margins of the Delta waterways in its initial colonization, but can eventually cover the entire channel if conditions permit. This level of infestation can produce barriers to salmonid migrations within the Delta.

The introduction and spread of *Egeria* and water hyacinth have created the need for aquatic weed control programs that utilize herbicides targeting these species. The EDCP resulted in the treatment of 1,583 acres in years 1-2; years 3-5 comprise the proposed project considered in this biological opinion (see *II. Description of the Proposed Action*). Diquat, the active ingredient of Reward®, has been shown to have a 96 hour LC_{50} (*i.e.,* lethal concentration at which 50 % of exposed test organism die) for salmonids at concentrations as low as 11 parts per million (ppm) for juveniles and potentially as low as 0.76 ppm for larval fish. Fluridone, the active ingredient of Sonar® has been shown to have a 96 hour LC_{50} of 7 to 12 ppm in rainbow trout (*O. mykiss*). Both herbicides are expected to have environmental concentrations one to two orders of magnitude lower than acutely toxic levels, but only after complete mixing in the water column. Furthermore, sublethal effects related to the herbicides may occur even at the lower concentrations, and indirect adverse effects from the dieback of the treated aquatic vegetation on water quality may cause take of listed salmonids within the treatment area.

The DBW control program targeting water hyacinth has been in operation from 1982 through 1999 in the Delta. It recently was reinstated, and it is expected that a long-term permit will be issued this year by NOAA Fisheries for the program's continued existence. DBW has employed herbicides as the preferred method of control for water hyacinth for 17 years. Chemicals previously utilized in DBW's control program included the aquatic herbicides Weedar®64 (2,4-Dichlorophenoxyacetic acid, dimethylamine salt; 2,4-D), Rodeo® (glyphosate, N-(phosphonomethyl) glycine (isopropylamine salt), and Reward® (diquat dibromide); the adjuvants Activator 90® (alkyl polyoxyethylene ether and free fatty acids), Placement® (amine salts of organic acids, aromatic acid, aromatic and aliphatic petroleum distillate), SR-11® (alkyl aryl polyethoxylates, compounded silicone and linear alcohol), Agri-dex® (paraffin base petroleum oil and polyoxyethylate polyol fatty acid esters), Bivert® (amine salts of organic acids, aromatic acid, aromatic and aliphatic petroleum distillates), and SurpHtac®(polyozyethylated (6) decyl alcohol, 1-aminomethanamide dihydrogen tetraoxosulfate); and the activator Magnify®(ammonium salts, aklyl polyglucoside, and dimethylpolysilozane). From 1983-1999, a total of 17,613 acres were treated with 4,861 applications of primarily 2,4-D (>95% of the total applied herbicides). For the last 6 years of the program, a total of 8,361 gallons of herbicide and 4,914 gallons of adjuvants were used in the Water Hyacinth Control Program (WHCP). An estimated 959 gallons of Weedar®64, 16 gallons of Rodeo®, and 320 gallons of Placement® were applied to Delta waters in the 2001 WHCP season, covering 1002 acres of Delta waters. The DBW estimates that it used a maximum of 900 gallons of herbicide on 500-1,000 acres of Delta waterways during the 2002 treatment season.

2,4-D has a 96 hour LC_{50} (*i.e.*, lethal concentration at which 50 % of exposed test organism die) ranging from 1.4 ppm to 358 ppm with a median of 27.3 ppm for rainbow trout, and a median of 14.8 ppm for Chinook salmon. Glyphosate has a 96 hour LC_{50} of 130 to 210 ppm depending on water hardness. As mentioned previously for the EDCP, herbicides applied under the WHCP are expected to have environmental concentrations one to two orders of magnitude lower than acutely toxic concentrations, but only after complete mixing in the water column. Sublethal effects related to the herbicides may occur even at these lower concentrations, and indirect adverse effects from the dieback of the treated aquatic vegetation on water quality may harm listed salmonids within the treatment area by interfering with their ability to forage and seek shelter in aquatic vegetation.

The previous two years of monitoring data for the WHCP have shown infrequent excursions for 2,4-D above the herbicide concentration criteria permitted (20 ppb) for the project under the NPDES permit. These elevated levels, however, remained below the label restrictions for this herbicide (*i.e.*, 100 ppb) and the results of biotoxicity testing were inconclusive for water samples taken from treatment sites. Likewise, the EDCP monitoring data indicated that the water column concentrations were below the labeled and NPDES concentration criteria for fluridone in all sites sampled and in all but one site for diquat residues in 2002. Results for 2001 were similar, but had a higher average concentration due to differences in the volume of water used for calculating treatment amounts (high tide volumes versus mean water level volumes). A few monitoring samples indicated biotoxicity to one or more of the test species exposed to sample water, but were inconclusive about the actual cause of the toxicity. Delta waters frequently contain a wide spectrum of chemical constituents, and without appropriate toxicity identification evaluations (TIEs), the root cause of the toxicity is difficult to pinpoint. DBW has yet to ascertain whether the control programs for either water hyacinth or *Egeria* substantially diminished the standing population of these invasive plants or resulted in the creation of areas with increased native aquatic plant growth.

Based on NOAA Fisheries' analysis in the 2001 and 2002 Biological Opinions and the results of the monitoring data reports, these past applications of herbicides were not likely to jeopardize any of the listed species or create adverse modifications to critical habitat. NOAA Fisheries did determine, however, that the programs would have adverse effects on the listed salmonids that were exposed to the herbicides and required reasonable and prudent measures be incorporated into the programs to reduce the impacts upon these fish and their habitat.

E. Habitat Restoration and Environmental Monitoring

Examples of habitat restoration projects conducted under the auspices of CALFED in the Delta region include large scale restoration projects on the Mokelumne and San Joaquin Rivers, purchase of additional upstream flows, and improvement of water quality throughout the watershed (CALFED 2000b). In general, habitat restoration projects are expected to increase habitat complexity or quality, and increase the growth and survival of rearing salmonids by creating conditions that increase the food supply or improve conditions for feeding and successful migration, and decrease the probability of predation.

FWS' Anadromous Fish Restoration Plan (AFRP) has developed numerous actions in the Delta specifically intended to improve the outmigration and survival of juvenile salmon in the Delta (*e.g.*, Delta Cross Channel closures, export curtailments, positive Q west conditions [positive delta outflow]; FWS 1997). AFRP actions also include non-flow fish management projects such as physical facilities to improve fish passage, channel restoration to improve rearing habitat and migration corridors, and fish screen installation to prevent the entrainment of juvenile fish.

The information gathered by the Interagency Ecological Program (IEP) monitoring program is used to adjust operations of the CVP and SWP. IEP projects explore predator-prey relationships; fish abundance and size distribution; geographic distribution, population studies; impacts from water operations; nursery values; entrainment monitoring; and fish screen criteria development. These projects serve not only to improve environmental conditions in the Delta, but also expand the knowledge base of the Delta's ecosystem. However, routine fish surveys conducted within the Delta almost universally results in the bycatch of listed salmonids, and thereby constitute an added source of mortality.

F. Summary

The general decline of habitat quality in the Sacramento-San Joaquin Delta has diminished the Delta's function both as a migratory corridor for juvenile and adult salmonids, and as rearing habitat for juvenile salmonids. The Delta is designated critical habitat for Sacramento River winter-run Chinook salmon.

Adverse impacts likely have been greatest on juvenile salmonids. Direct mortality of juvenile Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead resulting from entrainment in the CVP and SWP pumps is well-documented, as is predation by several introduced predator fish species on juvenile salmonids. Juveniles drawn into the South Delta from altered flow patterns experience lower survival rates presumably from these and other sources of mortality such as degraded water quality. In contrast, many habitat restoration projects and flow-related actions (e.g., Delta Cross Channel closures) specifically have been intended to improve conditions for juvenile salmonids. These likely have contributed to increased growth and outmigration success of juveniles, but population-level impacts have been difficult to quantify.

The proposed action exposes segments of the three listed salmonid populations to potentially toxic chemicals and impaired water quality during their migrations through the Delta. The more sensitive juvenile stages transit the Delta waters predominately in the spring and early summer, when the EDCP is starting its application schedule. Previous constraints on the timing and location of the early season herbicide applications have minimized the level of exposure to these stages and the current opinion intends to continue this preventative policy, and thus enhance the survivability of the salmonid stocks passing through affected waters.

V. EFFECTS OF THE ACTION

Pursuant to section 7(a)(2) of the ESA (16 U.S.C. §1536), Federal agencies are directed to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. This biological opinion assesses the effects of the EDCP on endangered Sacramento winter-run Chinook salmon and its critical habitat, threatened Central Valley spring-run Chinook salmon and threatened Central Valley steelhead. The EDCP is likely to adversely affect listed species and critical habitat through application of herbicides to waters of the Delta and the resulting short term alterations in the natural environment. In the *Description of the Proposed Action* section of this Opinion, NOAA Fisheries provided an overview of the action. In the *Status of the Species* and *Environmental Baseline* sections of this Opinion, NOAA Fisheries provided an overview of the threatened and endangered species and critical habitat that are likely to be adversely affected by the activity under consultation.

Regulations that implement section 7(b)(2) of the ESA require that biological opinions evaluate the direct and indirect effects of Federal actions and actions that are interrelated with or interdependent to the Federal action to determine if it would be reasonable to expect them to appreciably reduce listed species' likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (16 U.S.C. §1536; 50 CFR 402.02). Section 7 of the ESA also requires biological opinions to determine if Federal actions would destroy or adversely modify the conservation value of critical habitat (16 U.S.C. §1536).

NOAA Fisheries generally approaches "jeopardy" analyses in a series of steps. First, NOAA Fisheries evaluates the available evidence to identify direct and indirect physical, chemical, and biotic effects of the proposed action on individual members of listed species or aspects of the species' environment (these effects include direct, physical harm or injury to individual members of a species; modifications to something in the species' environment - such as reducing a species' prey base, enhancing populations of predators, altering its spawning substrate, altering its ambient temperature regimes; or adding something novel to a species' environment - such as introducing exotic competitors or a sound). Once NOAA Fisheries has identified the effects of the action, the available evidence is evaluated to identify a species' probable response (including behavioral responses) to those effects to determine if those effects could reasonably be expected to reduce a species' reproduction, numbers, or distribution (for example, by changing birth, death, immigration, or emigration rates; increasing the age at which individuals reach sexual maturity; decreasing the age at which individuals stop reproducing; among others). The available evidence is then used to determine if these reductions, if there are any, could reasonably be expected to appreciably reduce a species' likelihood of surviving and recovering in the wild.

A. Approach to Assessment

1. Information Available for the Assessment

To conduct the assessment, NOAA Fisheries examined evidence from a variety of sources. Background information on the status of these species and critical habitat, and the effects of the proposed action on the species and its environment has been published in a number of documents including peer reviewed scientific journals, primary reference materials, governmental and non-governmental reports, and scientific meetings as well as the supporting information supplied with the action's environmental documents.

2. Assumptions Underlying This Assessment

In the absence of definitive data or conclusive evidence, NOAA Fisheries must make a logical series of assumptions to overcome the limits of the available information. These assumptions are made using sound, scientific reasoning that can be logically derived from the available information. The progression of the reasoning will be stated for each assumption, and supporting evidence cited.

B. Assessment

The proposed period for EDCP treatment is from March 1 to November 30. The treatment period would overlap 4 months (50%) of adult winter-run Chinook salmon migration and 5.5 months (61%) of juvenile winter-run Chinook salmon emigration; most of the spring-run adult migration (80%) and juvenile emigration (60%); and 8.5 months (77%) of adult and juvenile steelhead migration in the Delta. During out-migration, the winter-run juveniles are at sub-yearling stage (age 0); spring-run juveniles are at yearling stage (age 1) and steelhead smolts are post-yearlings (age >1). However, herbicide application will be to discrete sections of the Delta, at specific time points in the application season. Thus, the Delta will not be globally impacted at a specific point in time, exposing all listed salmonids in the Delta at that moment to potentially toxic or adverse concentrations of herbicides; neither will any one segment of the Delta be treated continuously for the entire application season, inhibiting movement through it by listed salmonids.

Adult salmonids are not expected to be impacted by the EDCP, as they utilize deep water habitat which is not slated for EDCP chemical control treatments. However, the shallow water "nursery areas" targeted for chemical treatment in the Delta attract juvenile salmonids as these areas provide a rich food supply and protective cover for them. Salmon juveniles move from tidal channels during flood tide to feed in near-shore marshes. They scatter along the edges of the marshes at the highest points reached by the tide, then with the receding tide, retreat into channels that dissect marsh areas and retain water at low tide. Larger juveniles and smolts tend to congregate in surface waters of main and subsidiary slough channels and move into shallow subtidal areas to feed. Although there is some evidence that salmon and steelhead may not occur inside dense infestations of *Egeria* (McGowan 1998; Grimaldo *et al.* 2000), juvenile salmonids occurring along the edges of these areas would be vulnerable to impacts from the EDCP. The exact range of these effects would be hard to determine with any precision as they are dependent upon local conditions and physical environment which change with the application locale. These impacts may include physical disturbance during the herbicide application process and mechanical harvesting, direct exposure to chemical herbicides, various sublethal toxicity effects, and effects on habitat such as reduced DO levels, reduced food supply, and removal of native submergent aquatic vegetation.

1. Toxicity of EDCP Herbicides

In a study on toxicities of fluridone to aquatic invertebrates and fish, the acute median lethal concentrations of fluridone were 4.3 ± 3.7 mg/L (mg/L = ppm) for invertebrates, and 10.4 ± 3.9 mg/L for fish (Hamelink *et al.* 1986). Invertebrates were approximately three times more sensitive than fish on an acute basis but about equally sensitive on a chronic basis. However Paul *et al.* (1994) found that life stage was a critical factor in determining the sensitivity of fish to fluridone. This research found that the early life stages of fish were more sensitive than older life stages and that there were distinct species related sensitivities to the toxicity of fluridone. Paul *et al.* (1994) found that larval walleye (*Stizostedion vitreum*) were the most sensitive of the four different species of fish tested in their studies

(1.8 mg/L, 96 hr LC_{50}). This study found that the No Observed Adverse Effect Concentration (NOAEC) was 780 ppb for the same age walleye. Hamelink *et al.* (1986) found that rainbow trout exposed to fluridone had an 96 hr LC_{50} ranging from 4.2 mg/l to 11.7 mg/L with an average of 7.15 mg/L in the twelve different studies reviewed. Similar toxicity ranges are found in the EPA's ECOTOX database for rainbow trout. No chronic effects were appreciably detected in daphnids (*Daphnia magna*) at 0.2 mg/L concentration, amphipods (*Gammarus pseudolimnoeus*) at 0.6 mg/L, or midge larvae (*Chironomus plumosus*) at 0.6 mg/L. Channel catfish (*Ictalurus punctatus*) were not adversely affected by an exposure to 0.5 mg/L fluridone; however, their tissue had fluridone concentrations at two to nine times greater than that in the water column. Rainbow trout had an even higher bio-concentration of fluridone in their tissue, ranging from 2.3 in the edible tissue to 23.4 in the inedible portions with a whole body average of 15.5 (West *et al.* 1983). An initial fluridone concentration of 0.1 mg/L (ppm) or less is recommended to not adversely affect aquatic life (Hamelink *et al.*1986).

Reward® (*i.e.*, diquat) is moderately toxic to fish in fresh water with 96-hr LC_{50} values ranging from 10 - 30 mg/L (Lorz *et al.*1979, Etoxnet 2001). Toxicity of diquat to fish varies with species and life stage, and with water hardness and pH (Lorz *et al.*1979; Shaw and Hamer 1995). There is also some data that suggest that diquat is more toxic at higher temperatures (Paul *et al.*1994). Photodegradation plays a small part in the removal of diquat from the water column, but the Delta's hard water affords some protection to fish by the chelation of diquat. Label instructions for diquat specify that application rates in shallow water (<1 m) should be reduced, and diquat use should be discouraged in water bodies containing sensitive fish species during their early life stages (Paul *et al.*1994). Aquatic organisms are usually exposed to multiple lower-level exposures (Campbell *et al.* 2000). *Hyalella azteca*, an amphipod, is one of the most sensitive aquatic organisms tested with a 96-hour LC_{50} of 0.048 mg/L (Wilson and Bond 1969). The 8-hr LC_{50} for diquat is 12.3 mg/L in rainbow trout and 28.5 mg/L in chinook salmon. The 96-hr. LC_{50} for diquat is12 mg/L for rainbow trout and 28.5 mg/L for fingerling trout (Kamrin 1997). The use of diquat at recommended treatment levels could delay downstream migration of smolts and possibly affect their survival in seawater (Lorz *et al.* 1979). The EPA water quality criteria (1973) has established a criterion of 0.5 mg/L (ppm) diquat (instantaneous maximum) as the concentration that is protective of freshwater aquatic life.

Juvenile salmonids could be exposed to elevated concentrations of fluridone or diquat from the EDCP if they are present near the herbicide application point during the treatment process. Concentrations would remain high until the chemical is diluted from mixing with Delta waters. Rough estimates for herbicide concentration immediately following the initial application range from ten to twenty times the target concentration in the first six inches of water around the point of application. Lethal concentration of diquat may be reached temporarily in waters immediately adjacent to the injection point and prior to any mixing, but the duration of these concentrations are anticipated to be very short. Pelleted fluridone, due to its slow release characteristics, is not anticipated to reach the very high concentrations in close proximity to the compound application point as seen with diquat. However aqueous fluridone formulations will probably behave in a similar fashion as the aqueous diquat formulations. Mixing is expected to occur fairly rapidly (*i.e.*, minutes to hours) in most application sites. Once complete mixing occurs, then assuming the worst case scenario, and using the highest predicted environmental concentration (*i.e.*, 20 ppb) and the LC_{50} for rainbow trout (*i.e.*, 4.2 ppm), the instantaneous concentration for fluridone in the treatment area is expected to be approximately 200 times lower than the 96 hour LC_{50} for fluridone. Likewise for diquat when complete mixing occurs, then assuming the worst case scenario, and using the highest predicted environmental concentration (*i.e.*, 0.37 ppm) and the most sensitive LC_{50} (*i.e.*, 0.74 ppm), the instantaneous diquat concentration is still two times lower than the most sensitive LC_{50} values which are for larval fish. The instantaneous concentration, following complete mixing, is almost 77 times lower than the published LC_{50} values for chinook salmon and 31 times lower than those for rainbow trout.

Both fluridone and diquat are expected to be adsorbed to particulate matter suspended in the water and onto sediments on the bottom of the Delta waterways. Bacterial degradation will remove fluridone from the system and metabolize it to simple carbon compounds. Fluridone will also undergo photolytic decomposition. The half-life for fluridone in aquatic environments is approximately 21 days (Extoxnet 2002), but it may remain in bottom sediments from several weeks to one year (Muir and Grift 1982). Diquat chemically binds to sediment quickly (Ritter *et al.* 2000). Paul *et al.* (1994) found that sediment removed 60 percent of the diquat after four days in a shallow container which continued to be mixed by aeration. Several other field studies with variable results indicate the difficulty in ascertaining the time and rate of diquat dissipation (Yeo 1967), but apparently it can remain bioavailable for several days (Paul *et al.*1994). The environmental fate characteristics of both Sonar® and Reward® and the application rates used in the EDCP indicate that the long-term concentration levels of the herbicides achieved in Delta waters should be significantly below the acute toxicity levels of listed salmonids. However, recent medical studies in humans have shown correlations with the usage of herbicides, particularly phenoxy acetic acid herbicides (*e.g.*, 2,4- D) to increases in spontaneous abortions (Arbuckle, Lin and Mery 2001) in Ontario farm populations, presence of phenoxy residues in Ontario farmers' sperm (Arbuckle *et al.* 1999), parkinsonism from glyphosate exposure (Barbosa *et al.* 2001), short term decreases in immunological indices in farmers exposed to phenoxy herbicides (Faustini *et al.* 1996), and an increased risk of non-Hodgkin lymphoma from herbicide and pesticide exposures (Lynge 1998, Hardell and Eriksson 1999, McDuffie *et al.* 2001). The epidemiological data for humans exposed to herbicides would indicate that there is sufficient concern to warrant restricted usage of the compounds in aquatic environmental settings until more extensive physiological research is conducted.

In any case, sublethal effects and effects on habitat resulting from the EDCP that may ultimately increase the likelihood of mortality of salmon and steelhead are of concern, and are the category of effects that are most likely to occur during this program. Sublethal effects are characterized as those that occur at concentrations that are below those that lead directly to death. Sublethal effects may impact the fish's behavior, biochemical and/or physiological functions, and create histological alterations of the fish's anatomy. In addition, changes in the sensitivities of fish to other contaminants (*i.e.*, chemical synergism), particularly pesticides and other aromatic hydrocarbons, may increase the mortality of exposed fish. Degradation of habitat is expected to occur due to decreases in DO level due to *Egeria* decomposition, decreases in native vegetative cover, decreases in the invertebrate standing population which reduces the forage base available to juvenile salmonids, and changes in ambient water temperature due to changes in the amount of vegetative cover.

2. Sublethal Effects

In contrast to the acute lethality endpoints associated with the EDCP, nonlethal or sublethal endpoints may be more appropriate to the levels of exposure likely to be seen in the herbicide application protocol employed in the EDCP. Sublethal or nonlethal endpoints do not require that mortality be absent; rather, they indicate that death is not the primary toxic endpoint being examined. Rand (1995) states that the most common sublethal endpoints in aquatic organisms are behavioral (*e.g.*, swimming, feeding, attraction-avoidance, and predator-prey interactions), physiological (*e.g.*, growth, reproduction, and development), biochemical (*e.g.*, blood enzyme and ion levels), and histological changes (*e.g.*, degenerative necrosis of the liver, kidneys, and gill lamellae; Lorz *et al.* 1979). Some sublethal effects may indirectly result in mortality. Changes in certain behaviors, such as swimming or olfactory responses, may diminish the ability of the salmonids to find food or escape from predators and may ultimately result in death. Some sublethal effects may have little or no long-term consequences to the fish because they are rapidly reversible or diminish and cease with time. Individual fish may exhibit different responses to the same concentration of toxicant. The individual condition of the fish can significantly influence the outcome of the toxicant exposure. Fish with greater energy stores will be better able to survive a temporary decline in foraging ability, or have sufficient metabolic stores to swim to areas with better environmental conditions. Fish that are already stressed are more susceptible to the deleterious effects of contaminants, and may succumb to toxicant levels that are considered sublethal to a healthy fish.

a. Narcosis

Fish, when exposed to elevated concentrations of polar and nonpolar organic compounds such as the herbicides used in the EDCP, can become narcotized. Narcosis is a generalized nonselective toxicity response that is the result of a general disruption of cell membrane function. The process of narcosis is poorly understood, but is thought to involve either a "critical volume" change in cellular membranes due to the toxicant dissolving into the lipid membrane and altering its function, or by the "protein binding" process in which hydrophobic portions of receptor proteins in the lipid membrane are bound by the toxicant molecules, thus changing the receptor protein's function (Rand 1995). Exposure to elevated concentrations of the herbicides would occur in the immediate area of herbicide application, prior to dilution in the surrounding water column. A fish with narcosis would be more susceptible to predation as a result of a loss of equilibrium, a reduction in swimming ability or a lack of predator avoidance behavior. Furthermore, a fish with narcosis would also have difficulty maintaining its position in the water column, and could potentially be carried by water currents into areas of sub-optimal water quality where conditions may be lethal to salmonids (*e.g.*, hypoxic regions within *Egeria* mats).

b. Rheotropism

Rheotropism refers to fish behavior in a current of water, either directly as a response to water flowing over the body surface or indirectly as a response to the visual, tactile or inertial stimuli resulting from the displacement of fish in space (Dodson and Mayfield 1979). Fish respond physically and behaviorally to foreign stimuli (see App. A). Rainbow trout yearlings exposed to 0.5 ppm and 1.5 ppm of diquat for 24 hours exhibited no significant variation in the frequency of positive rheotaxis, exhibiting an increase in the frequency of no response and a significant decrease in swimming speeds caused by short-term exposure to diquat (Dodson and Mayfield 1979). Subtoxic effects of diquat on yellow perch (*Perca flavescens*) include a level of respiratory stress indicated by the cough response and reduced swimming speeds in exposure to 1.0 to 5.0 ppm diquat over 48 hours to 72 hours (Bimber *et al.* 1976). Fish exposed to diquat over longer periods of time may move passively downstream and into decreasing concentrations of diquat, exhibiting a passive avoidance response. The level of chemical absorption is dependent upon the fish species as well as individual fish characteristics. Hiltebran *et al.* (1972) exposed bluegills (*Lepomis macrochirus*) to diquat and demonstrated that as the length of exposure time increased, proportionally less diquat appeared to have been absorbed. It was unknown if this result was due to the metabolism, or elimination, of diquat. A "leveling off" of diquat residues in fish tissue was observed in increasing diquat concentrations rather than with increasing exposure time (Dodson and Mayfield 1979).

c. Chemical Interactions

Rand (1995) states that in "assessing chemically induced effects (responses), it is important to consider that in the natural aquatic environment organisms may be exposed not to a single chemical but rather to a myriad or mixture of different substances at the same or nearly the same time. Exposures to mixtures may result in toxicological interactions." A toxicological interaction is one in which exposure to two or more chemical residues results in a biological response quantitatively or qualitatively different from that expected from the action of each chemical alone. Exposure to two or more chemicals simultaneously may produce a response that is simply additive of the individual responses or one that is greater (synergistic) or less (antagonistic) than expected from the addition of their individual responses. Application of herbicides from the EDCP project may contribute to elevated toxicological responses caused by unknown sources of chemical compounds within the project area. Over 30 different herbicides are applied annually on agricultural lands in the Delta, and an additional 5 million pounds are applied upstream in the Sacramento River, San Joaquin River, and French Camp Slough (Kuivila *et al.* 1999). Chemicals used by the EDCP may build up on sediments at treatment sites. High additive concentrations of the various herbicides utilized in the Central Valley can potentially impair primary production in a defined geographic area (Kuivila *et al.* 1999) if contaminated waters come together in a confined area. Waters that flow through treated locations can carry herbicides to adjacent areas while concentrations in the water are still high enough to cause adverse impacts to aquatic organisms, if present, and possibly irrigation, municipal waste supplies and recreation.

Exposure of fish to the aromatic hydrocarbons typical of many families of herbicides and pesticides may result in the biotransformation of these compounds by various enzyme systems in the fish. Most organic contaminants are lipophilic, a property that makes these compounds readily absorbed across the lipid membranes of the gill, skin, and gastrointestinal tract. Following absorption, compounds that are susceptible to biotransformation are converted to more water soluble metabolites that are easier to excrete than the parent compound. Compounds that are resistant to metabolism are often sequestered in the lipid-rich tissues of the body. Although biotransformation is often considered a positive event in the detoxification of the contaminant, the parent compound of some contaminants are actually less toxic than the metabolites formed. These reactive intermediate metabolites can cause significant problems in other metabolic pathways, including alterations in the synthesis of DNA and RNA, redox cycling of reactive compounds, and induction of enzymatic systems that could lead to altered metabolism of environmentally encountered contaminants (Di Giulo *et al.* 1995). Within the Delta, mixtures of contaminants, particularly organophosphate pesticides (OP's) are common. Induction of the biotransforming enzymatic pathways, particularly the p450 monooxygenases, may actually increase the sensitivity of a fish to environmental contaminants. Organophosphate insecticides often are activated by the monooxygenase system (Murty 1986; Dr. M.J. Lydy, Southern Illinois University, Carbondale, personal communication, 2003). Thus, the higher the activity of the monooxygenase system, the more reactive metabolite formed.

In summation, all fish exposed to the chemical constituents in the herbicides will be expected to exhibit some level of adverse effects. Acute direct exposures to higher concentrations of the active ingredients can result in death. On the other hand, exposures to lower concentrations of the active ingredients in the herbicides will result in a spectrum of responses ranging from avoidance reactions and mild physiological disturbances to long term morbidity and shortened life span. Exposure of listed fish to these herbicides can significantly increase their vulnerability to predation from both piscine and avian predators. Symptoms of behavioral and physiological perturbations resulting from exposure often make affected fish stand out to predators from their unexposed cohorts. Longer term impacts will include a decrease in the physiological health of exposed fish after they leave the application area. These adverse effects are expected to be magnified by the conditions present in the Delta during the project's application schedule. The degraded habitat that is currently representative of the Delta exposes listed salmonids to a myriad of chemical constituents, many of which are known to have toxic effects on salmonids. The multiple exposures of the fish to different compounds in the water, in addition to the exposure of the fish to the active compounds in the EDCP's proposed herbicides, is likely to exacerbate the rate of morbidity and mortality in exposed fish. The indications of these adverse effects may not present themselves for days to months following the exposure, and may be very subtle in nature, but will produce fish with a lowered chance of survival and hence a lowered chance for contributing to the recovery of the fish's population.

3. <u>Effects on Habitat</u>

a. Physical Disturbance

Operation of the program's watercraft in the project area may result in effects due to wake turbulence, sediment resuspension, physical impact with propellers, and discharge of pollutants from the motor's exhaust and lubrication systems. These impacts may be exacerbated because the *Egeria*-infested areas tend to be shallow and the dense vegetation mats retain suspended particulates on their leaves. Wake induced turbulence in these areas disturbs the sediments captured by these plants and resuspends it all at once into the adjacent water column. The interaction of propellers with the vegetation shreds the plants into smaller fragments, some of which may retain their propagative viability if two internodes remain on the fragment.

Mechanical harvesting removes plants from the water by cutting them above their attachment point to the hydrosoil (mechanical cutting). Mechanical cutting is limited to relatively shallow waters, less than 10 feet deep. Cutter bars slice through the submerged stems of the plants and a conveyor belt-like mechanism moves the harvested plant material to a receiving craft or barge. When full, the barge moves to a shore mounted conveyor belt where it is transferred to a disposal vehicle. Mechanical harvesting has the potential to create significant amounts of viable fragments, which could then re-establish themselves elsewhere. In addition, the cutter bar assembly and harvesting apparatus may startle and drive listed salmonids out of the work area during its operation. However, the presence of juvenile salmonids in heavily infested areas where emergency mechanical harvesting may occur is unlikely due to their habitat preferences.

b. Dissolved Oxygen Levels

Juvenile salmonids may be directly affected through the reduction in DO levels resulting from the decomposition of plants killed by the herbicide application. Low DO levels (< 3 mg/L) can result in fish kills if fish are unable to move out of the zone of hypoxic or anoxic waters. Low dissolved oxygen levels are particularly harmful to salmonids, which have a high metabolic requirement for dissolved oxygen (Bjornn and Reiser 1991). Studies have shown that dissolved oxygen levels below 5 mg/L have a significant negative effect on salmonid growth, food conversion efficiency, and swimming performance. High water temperatures, which result in reduced oxygen solubility, can compound the stress on fish caused by marginal DO concentrations (Bjornn and Reiser 1991). Stress from low DO can make juvenile salmonids more susceptible to predation and disease, and less likely to smolt due to insufficient energy reserves. Adult salmonids may experience delayed migration through Delta waters if DO is below concentrations needed for survival. Delay in upstream migration can have a negative impact on the maturation of gonadal tissue, particularly if ambient water temperatures in the Delta are also elevated. Salmonids exposed to elevated temperatures during gonadal maturation have reduced fertility and lower numbers of viable eggs (CALFED 2000a). Fish exposed to DO levels below 5 mg/L for extended periods are usually compromised in their growth and survival (Piper *et al.* 1982). NOAA Fisheries expects that fish and mobile invertebrates will generally avoid areas with extensive infestations of *Egeria* due to the decreased ambient levels of DO in the water column. The increased biomass of the floating *Egeria* mat will increase the respiratory burden on DO during the night and limit light penetration to submerged portions of the plants during the day. Increased detrital deposition below the *Egeria* due to reduced water flow, and plant matter falling from the overlying mats will increase biological oxygen demand (BOD) in the affected areas of the infestation. The applications of herbicides are expected to initially decrease DO levels even further in areas treated for the plant. This results from the decomposition of the dead vegetable matter and an increase in BOD. This effect is expected to be transitory as the decaying vegetation is dispersed by tidal and river currents from the treatment area. Areas of higher tidal and river current exposure will be flushed faster than areas of low water body exchange, such as dead end sloughs and restricted peripheral channels. Additional parameters affecting the DO levels are the rate of decay for the treated vegetation which is dependent on ambient water temperature and microbial activity. Higher water temperatures should theoretically result in higher microbial activity, thus resulting in a faster decline in the DO levels. However, the duration of the depressed DO levels should be shorter than in a cooler temperature profile due to the vegetative biomass being metabolized at a faster rate. Conversely, a cooler ambient temperature would result in a prolonged DO depression, although perhaps not to the hypoxic levels reached in a warmer water profile.

c. Invertebrate Populations

Invertebrates could be exposed to elevated concentrations of fluridone or diquat from the EDCP if they occur within the immediate area of the initial application of the herbicidal concentrate to the water column. After mixing, however, the chemical compounds should not reach toxic levels to invertebrates if they are applied at the labeled rates. The volume of water available for dilution of the applied herbicide and the rate of water exchange will determine the extent of the elevated herbicide residues in the water column. The annual monitoring reports have indicated occasional elevated toxicity to *daphnia spp*. from monitored sites following herbicide applications, although direct correlations to the herbicide concentration has not been definitively made. Regions of low dissolved oxygen caused by drifting mats of decaying vegetation or smothering of benthic substrate may cause a localized decrease in populations and diversity of invertebrates. Many invertebrates have limited ability to migrate out of the treatment area, and thus are more susceptible to the effects of elevated herbicide concentrations or low dissolved oxygen levels. Following treatment, new populations of invertebrates are expected to re-establish themselves through larval recolonization of the area as soon as habitat conditions are suitable for their growth. Although the project's supporting material describes this mechanism, the project does not have actual data from the program to support this position. Nevertheless, juvenile salmonids will at least temporarily have to enlarge their foraging area to obtain sufficient prey to support their caloric needs. This may increase their exposure to predators, thereby decreasing their probability of survival. Also, the rate of survival for juvenile salmonids would be a balance between the amount of metabolic energy expended in swimming during foraging behavior versus the amount of caloric intake achieved from the prey captured during foraging. Caloric intake needs to exceed the metabolic cost of swimming in order for the juvenile fish to have sufficient energy reserves for growth and other metabolic needs.

d. Native Vegetation

There are potential impacts to native submerged and emergent vegetation especially if Sonar® (*i.e.*, fluridone) treatment is done adjacent to such areas and water column concentrations are sustained at treatment levels for approximately six weeks. Long-term exposure could significantly alter existing local plant community composition adjacent to these treatment sites due to the rates of recolonization and species abundance for pioneering plants. When applied at label rates, fluridone is toxic to other aquatic plants and agricultural crops it comes in contact with for an extended period of time.

Native submerged and emergent vegetation may be harmed or killed by the application of herbicides during the EDCP depending on the level of exposure. However, as with losses of invertebrates, NOAA Fisheries believes that a reduction in native vegetation would be temporary, as adjacent plants should recolonize the treated area. Removal of the thick mats of *Egeria* will allow light penetration to submerged plants in areas previously shaded by these mats. Likewise, *Egeria* will not be able to smother and abrade native emergent plants. Treated areas will also allow the native plants the opportunity to re-colonize without competing with *Egeria* for space and nutrient resources. During periods of juvenile salmonid migration, treated areas may not provide the necessary vegetative cover or food resources needed by the fish. Treatment could possibly magnify this impact, increasing the areas devoid of aquatic vegetation or having compromised water quality. NOAA Fisheries believes that these localized effects will reduce the probability of survival of juveniles emigrating through or rearing in the treatment area. Adjacent untreated acreage could be available to provide shelter and foraging for the juvenile salmonids as they move out of the treated area. However, expenditures of valuable metabolic reserves will have to be utilized for swimming to these new areas, making these reserves unavailable for other physiological needs like growth or smoltification. This shift in the utilization of metabolic energy stores has the potential to decrease the survival probability and physical health of the juvenile salmonid.

e. Beneficial Effects

Reductions in the percentage of *Egeria densa* infested waterways are likely to increase the habitat area available for use salmonids. It may also result in increased flows through these waterways, increased sunlight penetration, and re-establishment of native aquatic vegetation, and recolonization of native invertebrate species. These changes may result in positive effects on the suitability of the Delta waterways for salmonid rearing and migration.

VI. CUMULATIVE EFFECTS

Cumulative effects include the effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area considered in this biological opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultations pursuant to section 7 of the ESA.

Cumulative effects include ongoing point and non-point storm water and irrigation discharges related to agricultural and urban activities. These discharges contain numerous pesticides and herbicides that may adversely affect salmonid reproductive success and survival rates. Agricultural practices in the Delta may reduce riparian and wetland habitats through upland modifications of the watershed that lead to increased siltation or reductions in water flow in stream channels flowing into the Delta. Unscreened agricultural diversions throughout the Delta entrain all life stages of listed fish. Grazing activities from dairy and cattle operations can degrade or reduce suitable critical habitat for listed salmonids by increasing erosion and sedimentation as well as introducing nitrogen, ammonia, and other nutrients into the watershed, which then flow into the receiving waters of the Delta.

The Delta region, which includes portions of Contra Costa, Alameda, Sacramento, San Joaquin, Solano, Stanislaus and Yolo counties, is expected to increase its population by nearly 3 million people by the year 2020 (California Commercial, Industrial and Residential Real Estate Services Directory 2002). Increases in urbanization and housing developments can impact habitat by altering watershed characteristics, and changing both water use and stormwater runoff patterns.

Increased urbanization is expected to result in increased wave action and prop wash in Delta waterways due to increased boating activity. This potentially will degrade riparian and wetland habitat by eroding channel banks, thereby causing an increase in siltation and turbidity. Wakes and prop wash also churn up benthic sediments thereby potentially resuspending contaminated sediments and degrading areas of submerged vegetation. This in turn would reduce habitat quality for the invertebrate forage base required for the survival of juvenile salmonids. Increased boat operation in the Delta will likely also result in more contamination from the operation of engines on powered craft entering the water bodies of the Delta.

VII. INTEGRATION AND SYNTHESIS

The degree to which listed salmonids may be impacted by the EDCP is a function of their presence within the action area. The proposed period of implementation of the EDCP is from March 1 through November 30, which will overlap with more than half of the adult and juvenile migration periods for all of the runs. The period of greatest overlap with the listed juvenile salmonids in the Delta is during the higher flow periods of spring (*e.g.*, from March 1 through June 1) and fall (*e.g.*, October 1 through November 30). The remainder of the proposed application season corresponds to a period of low density of listed salmonids in the action area.

Based on the foregoing analysis, NOAA Fisheries anticipates that applications of Sonar® or Reward® to the waters of the Delta and its tributaries during the EDCP treatment seasons in an effort to control *Egeria densa* will not result in acute lethal effects to listed salmonids, unless fish are present in the immediate area during or immediately after the herbicide is applied and before dilution can occur through mixing. Nonetheless, there is the potential for the loss of a certain fraction of the migrating population that is exposed to the toxicants. Although fish should not be present in the cores of *Egeria* mats, they may be present along the periphery of the mats, utilizing it for cover from overhead predators. Thus, fish may be exposed to lethal or sublethal concentrations of herbicides that are applied to the margins of the mat or to herbicides present in the water column directly below the mat or flowing out of the area of application.

The most important impacts of the EDCP are expected to occur to juvenile salmonids, and include sublethal effects and effects to habitat. As stated in Rand (1995), sublethal effects to listed salmonids can be expected to take the form of behavioral, physiological, biochemical, or histological changes in the exposed fish. These changes may not be immediately lethal, but can cause fish to exhibit impaired behaviors (*e.g.*, narcosis) or eventually develop a lesser level of physical health, thus reducing their chances of survival as compared to unexposed fish. Possible consequences include loss of equilibrium and reduced swimming ability and predator avoidance behavior, which could lead to increased predation risk or reduced foraging ability. Chemical synergism between the EDCP herbicides and other contaminants in the Delta could occur and exacerbate these effects.

The EDCP is expected to result in several temporary degraded habitat conditions. These are expected to include physical disturbance, elevation of water temperature caused by reduced shading, reduction of dissolved oxygen levels resulting from decaying *Egeria*, reduction in the invertebrate forage base for juvenile salmonids, and reduction of native vegetation which juvenile salmonids may utilize for cover. Even though juvenile salmonids should be able to leave or avoid areas of degraded habitat, they may need to expend valuable metabolic energy to do so. This could result in depleted energy stores that could have been used for other physiological needs, such as growth or smoltification.

Notwithstanding the predicted impacts to fish and the Delta habitat described above, the magnitude of effects on a Delta-wide scale is expected to be less severe. The Delta has approximately 50,000 acres of waterways. DBW has determined that approximately 3,900 acres are infested with *Egeria*, primarily in the central and southern portions of the Delta. Of this acreage, DBW has prioritized the treatment of 1,733 acres at 35 sites (see Table 1) amounting to 3.5% of the total Delta waterway acreage. Although Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead are known to occur in the central and southern portions of the Delta, where the treatment program will be focused, the majority of the listed fish populations (*i.e.*, approximately two thirds) utilize the Sacramento River channel through the northern section of the Delta as their primary migration corridor out to the waters of the San Francisco Bay estuary. Given this divergence between the geographical location of the listed fish species during their migratory movement through the Delta and the geographical limits of the program’s herbicidal applications, the best current estimate is that at maximum, only one third of the populations could be exposed to the program's herbicides. The actual value is likely far less than this due to the application practices of the EDCP. The DBW has a limited number of spray boats (*i.e.*, fewer than a dozen) that can be active on any given day. Therefore, only a fraction of the 35 sites can be treated in any given day; each treatment site ranges from a few acres to over 150 acres, and treatment of an individual site can take from as little as a few hours to several days to complete. In addition, juvenile salmonids are expected to occur only along the periphery of the *Egeria* mat and not within the interior of the mat. As a result, NOAA Fisheries reasons that very few listed salmonids will be present within areas of toxicological effect. The duration of elevated herbicidal concentrations in the peripheral waters will depend on the rate of mixing that occurs and the subsequent dilution of the herbicide applied to the mat as well as other physical conditions such as adsorption to suspended matter in the water column and water hardness. The dilution of applied herbicides will occur over a period of minutes to hours, dependent on current velocity, tidal stage and local water quality. These parameters will invariably change on both a spatial and temporal scale in the described action area. Therefore, NOAA Fisheries expects that areas with elevated herbicide concentrations will be both small and transient in nature, resulting in low levels of exposure to salmonids migrating through the action area and transitory impacts on critical habitat. Degraded habitat conditions eventually will be attenuated as DO levels increase and invertebrates recolonize treated areas. In addition, the removal of *Egeria* eventually may improve habitat conditions for juvenile salmonids if water flow improves and native vegetation colonizes the treated areas, creating shaded habitat.

While there will be negative impacts to a proportion of the listed salmonid populations that are within the immediate vicinity of a herbicidal application at the moment of application or immediately following it, the exact proportion of each ESU affected by the application is difficult to determine since the density of migrating fish and the timing of migration can vary annually and within seasons based on a myriad of factors. However, as discussed above, only a small segment of each listed salmonid race is expected to be actually exposed to concentrations sufficiently elevated to have a negative impact on the individual fish. Effects of primary concern are sublethal, as few or no fish are likely to be directly killed during herbicide application. Sublethal effects such as behavioral changes (*e.g.*, swimming, feeding, attraction-avoidance, and predator-prey interactions), physiological changes (*e.g.*, growth, reproduction, and development), biochemical changes (*e.g.*, blood enzyme and ion levels), and histological changes (*e.g.*, degenerative necrosis of the liver, kidneys, and gill lamellae) are expected in the fish that are exposed to areas of elevated herbicide and surfactant concentrations. However, based on the low likelihood of fish exposure to these levels and the small numbers of salmonids likely affected, this level of impact is not expected to detectably reduce the numbers, reproduction, or distribution of the cohorts affected during each year of treatment.

VIII. CONCLUSION

After reviewing the best available scientific and commercial information, the current status of the Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead, the environmental baseline, the effects of the proposed *Egeria densa* Control Program for years 2003 through 2005, and the cumulative effects, it is NOAA Fisheries' biological opinion that the EDCP, as proposed, is not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, or Central Valley steelhead, or result in the destruction or adverse modification of the designated critical habitat for Sacramento River winter-run Chinook salmon.

Notwithstanding this conclusion, NOAA Fisheries anticipates that some activities associated with this project may result in the incidental take of these species. Therefore, an incidental take statement is included with this Biological Opinion for these actions.

IX. INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NOAA Fisheries as an act which kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary and must be undertaken by the USDA-ARS so that they become binding conditions of any grant or permit issued to the DBW, as appropriate, for the exemption in section 7(o)(2) to apply. The USDA-ARS has a continuing duty to regulate the activity covered in this Incidental Take Statement. If the USDA-ARS: (1) fails to assume and implement the terms and conditions of the Incidental Take Statement, and/or (2) fails to require the DBW to adhere to the terms and conditions of the Incidental Take Statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the USDA-ARS and the DBW must report the progress of the action and its impact on the species to NOAA Fisheries as specified in this Incidental Take Statement (50 CFR § 402.14 (i)(3)).

This Incidental Take Statement is applicable to the operations of the EDCP as described in the Draft Environmental Impact Report (March 2000; DBW 2000a), EDCP Monitoring Plan (November 2002; DBW 20002) and the EDCP: Addendum to 2001 Environmental Impact Report (DBW 2003). All applications of permitted herbicides as described in the project description for the program will have incidental take coverage as stipulated under the terms of section 7(b)(4) and section 7(o)(2) of the ESA during the operational season approved by NOAA Fisheries (*i.e.*, applicant's March 1 through November 30 application season) for the years 2003 through 2005, providing that the terms and conditions of this biological opinion are implemented. The incidental take coverage for this biological opinion will terminate following the close of the 2005 application season. After this time, incidental take of listed salmonids by the EDCP will not be exempt from the take prohibitions of section 9 of the ESA under the authority of this biological opinion.

A. Amount or Extent of Take

NOAA Fisheries anticipates that the proposed EDCP will result in the incidental take of Central Valley spring-run Chinook salmon, Sacramento River winter-run Chinook salmon, and Central Valley steelhead due to direct and indirect impacts caused by the application of chemical herbicides to waters of the Delta. Any incidental take resulting from the project will most likely be limited to emigrating fry and juveniles present in the Delta action area during the operational season of the EDCP. The incidental take is expected to be in the form of death, injury, harassment, and harm.

The numbers of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead directly taken will be difficult to quantify because dead and injured individuals will be difficult to detect and recover. However, take is expected to include:

1. All Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon and Central Valley steelhead juveniles harmed or killed from exposure to lethal or sublethal concentrations of fluridone or diquat applied to waters of the Delta during implementation of the EDCP (applicant's proposed implementation period from March 1 through November 30) for the years 2003 through 2005. Sublethal exposure may cause behavioral changes (*e.g.*, narcosis) or declines in physical health that may result in decreased growth or increased likelihood of predation.

2. All Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead juveniles harmed, harassed, or killed from altered habitat conditions caused by the application of fluridone or diquat to the waters of the Delta during implementation of the EDCP (applicant's proposed implementation period from March 1 through November 30) for the years 2003 through 2005. Such conditions may include reduced DO levels, reduced food supply, physical disturbance, and consequent avoidance of habitat and increased energy expenditure and likelihood of predation.

B. Effect of the Take

In the accompanying biological opinion, NOAA Fisheries determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

C. Reasonable and Prudent Measures

Pursuant to section 7(b)(4) of the ESA, the following reasonable and prudent measures are necessary and appropriate to minimize take of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon and Central Valley steelhead.

1. Measures shall be taken to reduce impacts to juvenile Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon and Central Valley steelhead from chemical control treatment and/or monitoring activities.

2. Measures shall be taken to reduce the impact of DBW's EDCP boating operations on Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead and their habitat.

3. Measures shall be taken to monitor the DBW's EDCP operations and the ambient Delta hydrologic conditions.

D. Terms and Conditions

In order to be exempt from the prohibitions of Section 9 of the Act, the USDA-ARS must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. Measures shall be taken to reduce impacts to juvenile Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon and Central Valley steelhead from chemical control treatment and/or monitoring activities.

A. Chemical controls for the EDCP in the Delta shall not be applied before April 1 of each control season in any portion of the action area. Applications of herbicides may be conducted in areas of the Delta as follows:

1. The following sites may be treated after April 1 of each application season. Treated sections should start at the inner margin of the infested water body and move progressively outwards towards the main channels

:

a. White Slough, east of Honker Cut;
b. Disappointment Slough, east of Honker Cut;

c. 14 Mile Slough, 0.5 miles upstream of the San Joaquin River;
d. Seven Mile Slough, 0.5 miles upstream of confluences with the San Joaquin River and Three Mile Slough;
e. Pixley Slough
f. Bishop/ Telephone Cut

2. The following sites can be treated as of April 15 of each application season:
 a. Old River Del's after the temporary barriers are in place;
 b. Paradise Cut after the temporary barriers are in place

3. Chemical controls for the EDCP in the rest of the Delta may be applied after June 1 if technical guidance on real-time juvenile migration provided by IEP Real-Time Monitoring (found on the Internet at: http://www.delta.dfg.ca.gov/) and verbal verification from NOAA Fisheries, indicates that outmigration has concluded for the season for listed salmonids. Dependent upon type of year and in-stream flows, juvenile steelhead may be present in the Delta through May, and winter-run and spring-run Chinook salmon may be present in the Delta through June.

4. The EDCP may operate from July 1 through October 15 without restriction to locations treated throughout the project area; chemical controls for the EDCP shall not be applied after October 15 of each treatment season.

B. Any Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead trout mortalities found at or in the vicinity of a treatment site shall be collected, fork length measured and the body placed in a whirl-pak bag. The bag will be labeled with the time, date, location of capture, and a description of the near-shore habitat type and water conditions and frozen. NOAA Fisheries, Sacramento office shall be notified as soon as possible of any mortalities at 916-930-3600 and a representative of NOAA Fisheries will collect the specimen.

C. DBW staff and their assigned agents must follow all Federal and State laws applicable to the use of the herbicides and any adjuvants and apply them in a manner consistent with the product labeling, the NPDES General Permit, Proposed Action, and determinations from the California Department of Pesticide Regulation.

D. Fish passage shall not be blocked within treatment areas. Protocols shall be followed to ensure that EDCP operations do not inhibit passage of fish in each area scheduled for treatment or exceed limitations on contiguous treated acreage.

E. The DBW will provide a copy of each week's Notice of Intent (NOI) to Jeff Stuart, Fishery Biologist, Protected Resources Division, 650 Capitol Mall, Suite 8-300, Sacramento, CA 95814, by the Friday prior to the treatment week. This notification will include the sites scheduled for treatment and a contact person for those sites.

F. Jeff Stuart will be the appointed NOAA Fisheries representative on the *Egeria densa* Task Force, and provide technical assistance to the Task Force along with carrying out the duties of a Task Force member. As part of the EDCP Task Force, the NOAA Fisheries representative will be active in guiding decisions on prioritizing treatment sites in regards to the presence of salmonids.

2. Measures shall be taken to reduce the impact of DBW's EDCP boating operations on Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead and their habitat.

A. USDA-ARS and DBW shall comply with the receiving water limitations of the NPDES General Permit issued for the EDCP in regards to oils, greases, waxes, floating material, or suspended material derived from the operation of program vessels or application activities

B. The USDA-ARS and DBW shall ensure that any mixing of chemicals, or disinfecting and cleaning of any equipment shall be done in strict accordance with the operational protocols of the EDCP and that all equipment is in working order prior to engaging in application activities, including the operation of the program's vessels.

C. Operation of program vessels in shallow water habitats shall be done in a manner that causes the least amount of disturbance to the habitat. Operational procedures for vessels in these habitats shall minimize boat wakes and prop wash.

D. Operation of program vessels shall avoid or minimize to the greatest practicable extent dislodging portions of existing *Egeria densa* beds that can drift into other areas. This avoids creating new infestations of the weed due to drifting fragments.

3. **Measures shall be taken to monitor DBW *Egeria densa* control operations and Delta hydrologic conditions**.

A. The USDA-ARS shall ensure that the DBW follows a comprehensive monitoring plan designed to collect project operational information. The monitoring plan shall adhere to the requirements of the NPDES General Permit and have at a minimum those water quality criteria stated in Attachment B of the permit, *i.e.*, data on water temperatures, dissolved oxygen, pH, turbidity, water hardness, electrical conductivity and chemical concentrations in the application areas as well as other criteria stated in the attachment. Determinations of chemical concentrations shall have at a minimum, pre- and post-application water samples taken at the furthest down current site of the application zone. Previous water sampling protocols provided only a minimal accounting of chemical dispersion profiles. In order to provide a more complete profile of initial dispersion rates, water samples shall be drawn at the following depths below the water surface: 0.5, 1, 2, 4 feet, and one foot above the bottom, within five minutes of cessation of the application of the herbicide(s). Additional tests, if required by other federal and state agencies, shall be conducted and the information made available to NOAA Fisheries. The results of this monitoring program will be used to determine if the DBW is affecting Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, or Central Valley steelhead trout to an extent not previously considered.

B. The USDA-ARS, in coordination with the DBW, shall provide monitoring reports of the hydrologic conditions and the amounts of chemical discharges every other month to Jeff Stuart, NOAA Fisheries-Sacramento Field Office. These reports shall also include information on the following parameters:

1. Pre-treatment and post-treatment measurements on chemical residues, pH and turbidity levels as well as water temperatures and dissolved oxygen concentrations from pre-selected sites in the Delta. These sites shall be reflective of the different water types found in the range of application sites and will be determined by DBW as part of their NPDES General Permit conditions.

2. Receiving water temperatures and dissolved oxygen levels and resultant changes in those conditions resulting from EDCP operations.

3. Amounts, types and dates of application of herbicides applied at each site.

4. Visual assessment of pre- and post-treatment conditions of treated sites to determine the efficacy of treatment and any effects of chemical drift on downstream habitats immediately adjacent to the treated sites.

5. Operational status of equipment and vessels, including repairs and spraying equipment calibrations as needed.

C. The USDA-ARS, in coordination with the DBW, shall summarize the above monthly reports into an annual report of the DBW project operations, monitoring measurements and Delta hydrological conditions for the previous treatment year for submission to NOAA Fisheries by January 31, of each year. The annual report of DBW operations shall also include:

1. A description of the total number of winter-run and spring-run chinook salmon or steelhead observed taken, the manner of the take, and the dates and locations of the take, the condition of the winter-run chinook salmon, spring-run chinook salmon, or steelhead trout taken, the disposition of fish taken in the event of mortality and a brief narrative of the circumstances surrounding the take of the fish. This report shall be sent to the address given below.

2. Listed salmonids or other fish species that are observed to be behaving in an erratic manner shall be reported (see Appendix A).

D. All bi-monthly reports and the annual report shall be submitted by mail or Fax to:

NOAA Fisheries-Sacramento Field Office
Attn: Jeff Stuart
650 Capitol Mall, Suite 8-300
Sacramento, California 95814
Fax: (916)930-3629

X. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on a listed species or critical habitat or regarding the development of pertinent information.

1. The USDA-ARS and DBW should support anadromous salmonid monitoring programs throughout the Sacramento-San Joaquin Delta to improve the understanding of migration and habitat utilization by salmonids in the Delta region.

2. The USDA-ARS and DBW should support and promote aquatic and riparian habitat restoration within the Delta region, and encourage practices that avoid or minimize negative impacts to salmon and steelhead.

3. The USDA-ARS and DBW should encourage alternate non-chemical controls of Egeria densa and other non-native invasive vegetation in the Sacramento/San Joaquin Delta and its tributaries, in conjunction with a native plant re-vegetation program.

4. The USDA-ARS and DBW should increase public awareness of the potential threats to proper ecosystem function by exotic species introductions such as Egeria.

5. The USDA-ARS and DBW should promote state legislation and/or regulations to limit the importation and marketing of Egeria and other exotic invasive species, and to prevent future exotic species introductions into the state through nursery, agricultural, or boating activities.

6. The USDA-ARS and DBW should promote the conservation measures specified in Appendix A of Amendment 14 to the Pacific Coast Salmon Plan as they pertain to agricultural practices in the project area through education, extension programs, and research.

In order for NOAA Fisheries to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, NOAA Fisheries requests notification of the implementation of any conservation recommendations.

XI. REINITIATION OF CONSULTATION

This concludes formal consultation on the actions outlined in the November 16, 2002 request for consultation received from the USDA-ARS. This biological opinion is valid for the project described for the years 2003 through 2005. As provided for in 50 CFR§402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of taking specified in any incidental take statement is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the agency action is subsequently modified in a manner that causes an affect to the listed species that was not considered in the biological opinion; or (4) a new species is listed or critical habitat is designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

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TABLE 1: EDCP Application Sites

Site Number	Site Name	Acreage	Description	% Waterbody Surface Acreage Covered with Egeria	Approx. Depth of Egeria
1	Frank's Tract	158	Large, open, and shallow water body in the western Delta	26	7
2	Venice Cut	147	Narrow channel in central Delta, south of Venice Island,east of Empire Tract	17	8
3	Big Break	23	Large, open,and shallow water body in western delta, no flow through capacity	21	5
4	Sherman Island	23	Large, open, and shallow water body in the western Delta	25	4
5	Rock Slough	37	Heavily infested slough running from south end of Sandmound Slough to Old River, south of Holland Tract	34	6
6	White slough	129	Slough north of Empire Tract and King Isalnd, running from Little Potato Slough to Telephone Cut	31	6
7	Fisherman's Cut	21	Cut directly north of False River at western side of Frank's Tract to the San Joaquin River	21	8
8	Taylor Slough	13	Slough on west end of Frank's Tract, running around Bethal Island and south to Dutch Slough	9	8
9	Sandmound Slough	38	Slough on west side of Holland Tract from Quimby Island to Rock Slough	17	8
10	Pipers Slough	19	Slough on southwest corner of Frank's tract connecting to Sandmound Slough	12	8
11	Lathum Slough	104	Slough on west side of McDonald Island, off of Middle River, in central Delta	16	8
12	Disappointment Slough	76	Slough south of Empire Tract and King Island, running rfom Stockton Deep Water Channel to Pixley Slough	14	7
13	Old River Del's	23	Portion of Old River south of Clifton Court Forebay near Del's Boat Harbor	8	8
14	Old River Connection	37	Most northerly portion of Old River where it joins Connection Slough north of Bacon island	19	7
15	Middle River Bullfrog	57	Portion of mIddle River next to Bullfrog Landing, west of Lower Jones Tract and south of Mildred Island	19	6
16	Middle River Jones	38	Portion of Middle River west of Upper Jones Tract and south to Woodward Canal	19	4
17	14 Mile Slough	52	Slough east of Stockton Deep Water Channel on the north side of Lower Roberts Island beginning near Windmill Cove Marina	19	6
18	Middle River Victoria	20	Portion of Middle River between Woodward Canal and Union Point east of Victoria Island	14	8
19	Donlon Island	12	Heavily infested island on east side of Sherman Isalnd, bordering the San Joaquin River	50	8
20	Rhode Isalnd	88	Island on the northwest side of Bacon Island, bordering Holland tract alnog Old River	28	5
21	Big break Wetlands	55	Heavily infested area on westernmost side of Big Break	77	8
22	Big Break II	3	Heavily infested area on southwest corner of Big Break	32	8
23	Seven Mile Slough	23	Slough on western portion of treatment area, north of Webb Tract	7	4
24	Dutch Slough	63	Heavily traveled slough connecting Big Break to Sandmound Slough through Bethel Island	18	9
25	Little Potato Slough	30	Slough connecting Potato Slough with White's Slough at itersection of Venice Island and Empire Tract	11	6
26	Turner Empire Cut	17	Cut intersecting Latham Slough at Mildred Island with Stockton Deepwater Channel, north of Lower Jones Tract and Roberts Island	8	6
27	Little Venice Island	12	Small island bordered by Mandeville Island to west, Medford Island to east and Venice Cut to north	27	6
28	Coney Island	12	Island on east side of Clifton Court Forebay	24	6
29	Hog Island	12	Island east east of McDonald Isalnd, bordering the Stockton Deep Water Channel and Hog Cut	5	6
30	Pixley Slough	27	Slough on east side of Delta, south of Bishop Tract, beginning at Paradise Point Marina	12	8
31	Bacon Island	30	Areas around Bacon Island in central Delta	18	8
32	Paradise Cut	18	Cut on southern edge of Delta, south side of Stewart Tract intersecting Old River	10	8
33	Bishop Telephone Cut	7	Located on eastern edge of Delta, running along west side Bishop Tract and including Telephone Cut	7	8
34	Old River Orwood	90	Portion of Old River bordering Orwood Island	20	8
35	Potato Slough	48	Slough north of Venice Island between Stockton Deep Water Channel and Little Potato Slough	11	8

Figure 1: **Delta Waterways**

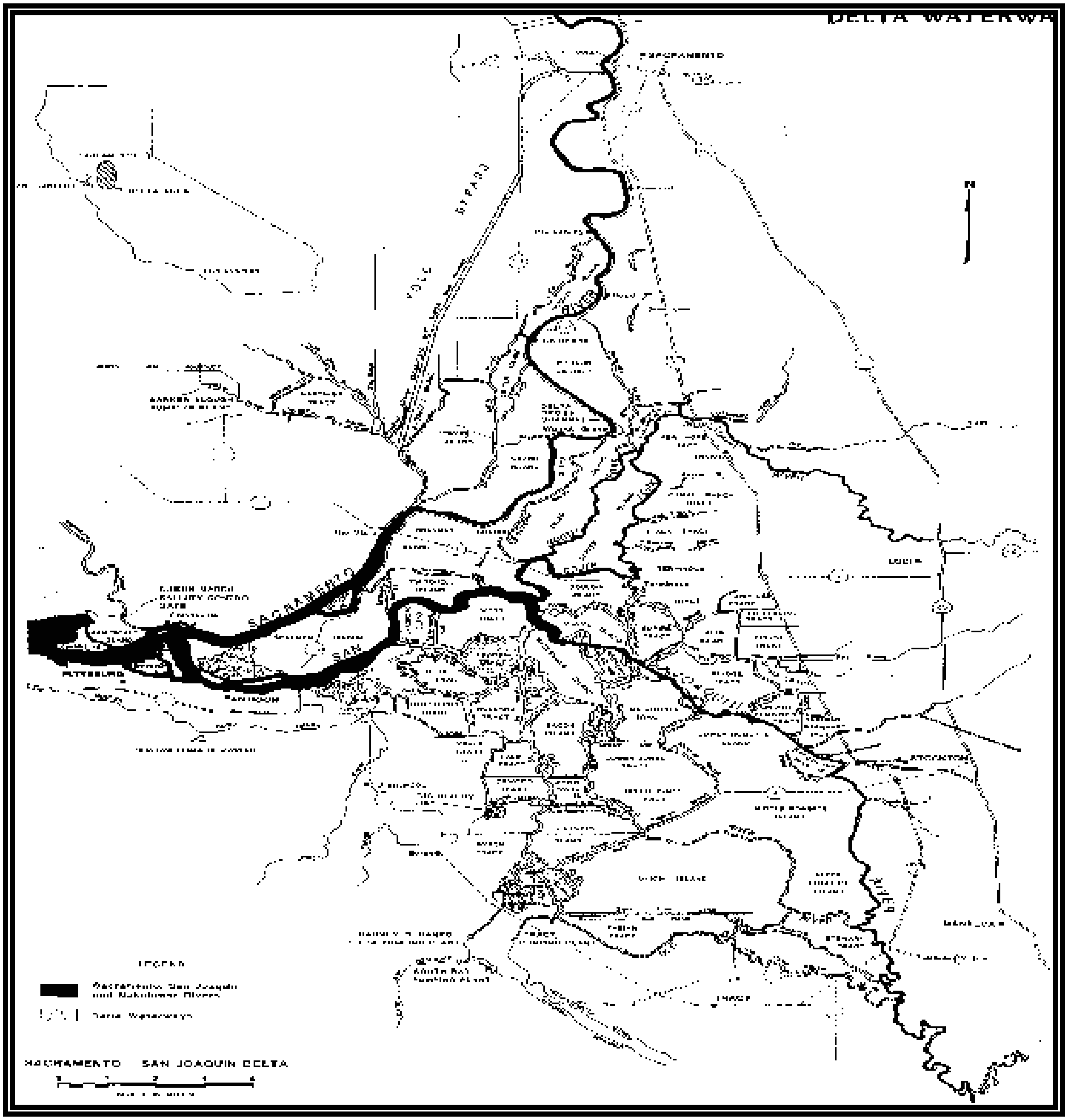
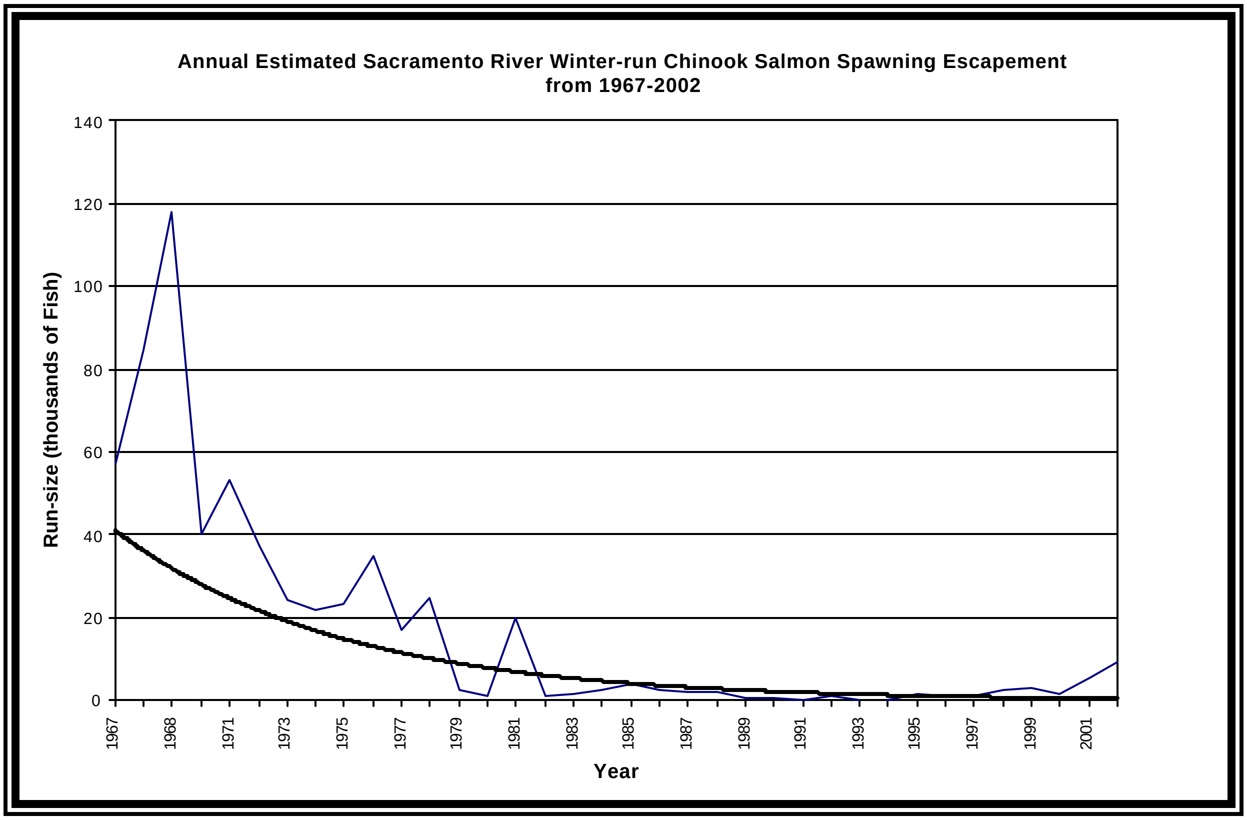
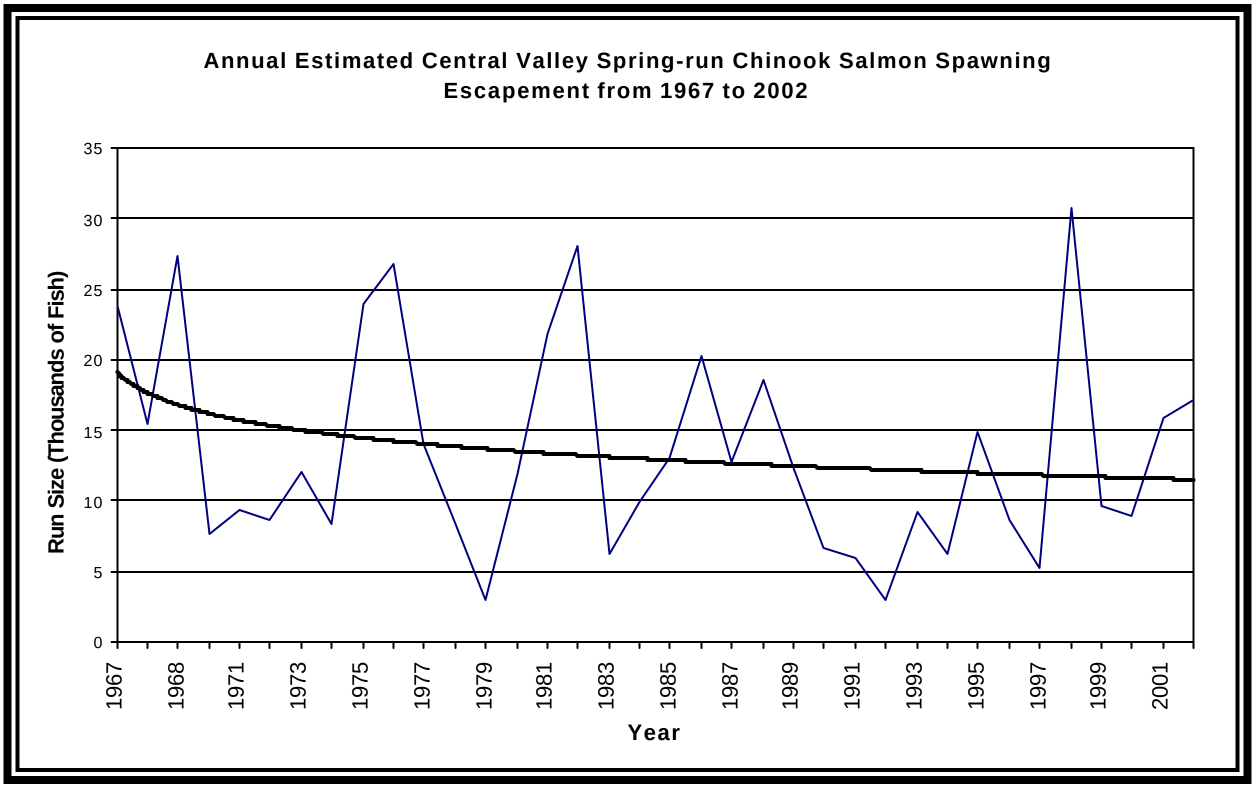


Figure 2: Sources NMFS 1997, PFMC 2002



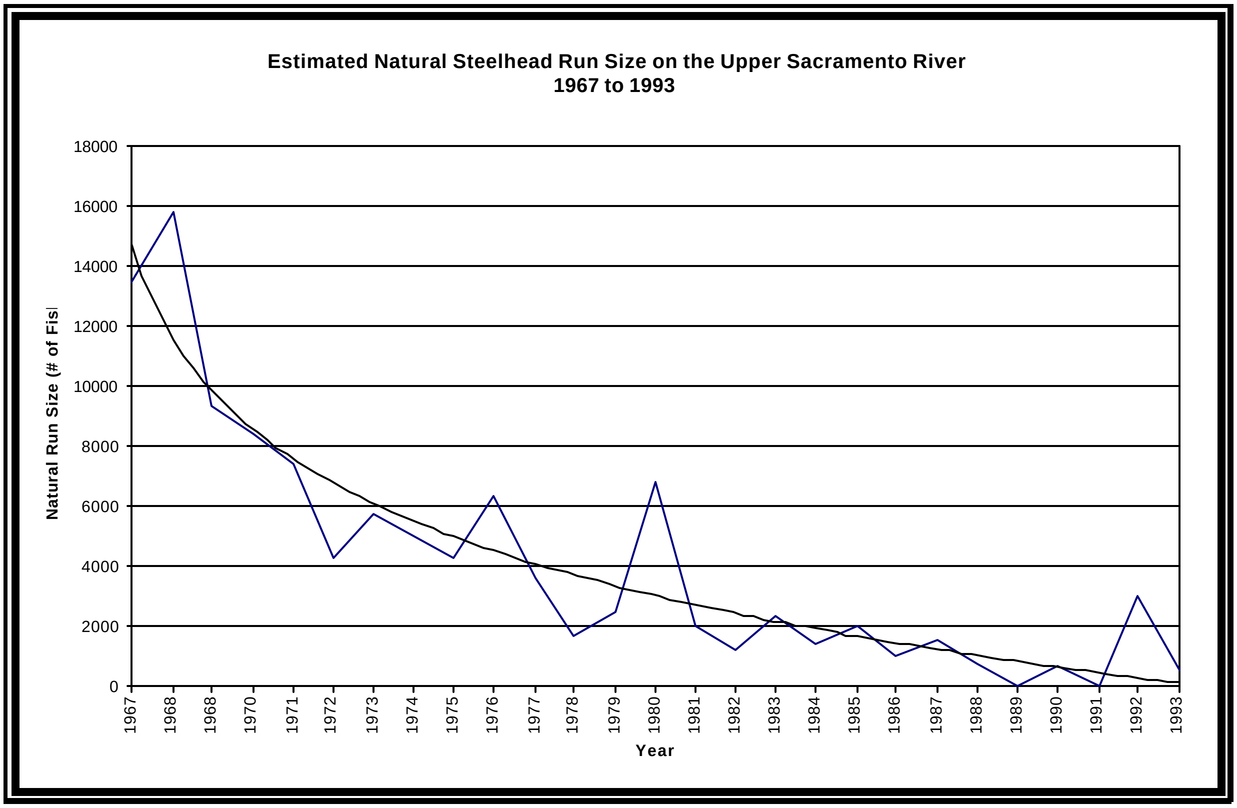
Trend line for Figure 2 is an exponential function: $Y = 46.606\ e^{-0.1269x}$ $R^2 = 0.5449$

Figure 3: Source PFMC 2002, Yoshiyama 1998.



Trend line for Figure 3 is an exponential function: Y = -2.1276 Ln (x) + 19.146, $R^2 = 0.0597$

Figure 4: Source McEwan and Jackson, 1996



Note: Steelhead escapement surveys at RBDD ended in 1993

Trend line for Figure 4 is a logarithmic function: Y= -4419 Ln(x) + 14690 $R^2 = 0.8574$

Appendix A.

<u>Physical Effects and Avoidance Behavior in Fish due to Chemical Contamination</u>

"The death of some organisms, such as mysids and larval fish, is easily detected because of a change in appearance from transparent or translucent to opaque. General observations of appearance and behavior, such as erratic swimming, loss of reflex, discoloration, excessive mucus production, hyperventilation, opaque eyes, curved spine, hemorrhaging, molting, and cannibalism, should also be noted in the daily record" (Section 10.1.3, Weber, 1993).

Overt Signs of Fish Distress

I. Respiratory stress - hyperventilation.
II. Disorientation in swim pattern, induced by narcosis.*
III. Mucus secretions from gills, mouth distension or 'cough' reflex.

Behavioral Response

I. Actively move from area of contamination.
II. Reduced swimming rate.
III. Passively be carried away from the area (some chemical impact to fish).
IV. Lethal concentration causes fish mortality. Fish rise to water surface, ventral-side up, with distended belly, no respiration, rigor mortis.

*Narcosis: a general, nonspecific, reversible mode of toxic action that can be produced in most living organisms by the presence of sufficient amounts of many organic chemicals. Effects result from the general disruption of cellular activity. The mechanism producing this effect is unknown, with the main theories being binding to proteins in cell membranes and 'swelling' of the lipid portion of cell membranes resulting from the presence of organic chemicals. Hydrophobicity dominated the expression of toxicity in narcotic chemicals.

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Enclosure 2.

Magnuson-Stevens Fishery Conservation and Management Act (MSA)

ESSENTIAL FISH HABITAT CONSERVATION RECOMMENDATIONS

I. IDENTIFICATION OF ESSENTIAL FISH HABITAT

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended (U.C. 180 *et seq.*), requires that Essential Fish Habitat (EFH) be identified and described in federal fishery management plans (FMPs). Federal action agencies must consult with the National Marine Fisheries Service (NOAA Fisheries) on any activity which they fund, permit, or carry out that may adversely affect EFH. NOAA Fisheries is required to provide EFH conservation and enhancement recommendations to the federal action agencies.

EFH is defined as those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purposes of interpreting the definition of EFH, "waters" includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary' means habitat required to support a sustainable fishery and a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers all habitat types used by a species throughout its life cycle. The proposed project site is within the region identified as Essential Fish Habitat (EFH) for Pacific salmon in Amendment 14 of the Pacific Salmon Fishery Management Plan and for starry flounder (*Platicthys stellatus*) and English sole (*Pleuronectes vetulus*) in Amendment 11 to the Pacific Coast Groundfish Fishery Management Plan.

The Pacific Fishery Management Council (PFMC) has identified and described EFH, Adverse Impacts and Recommended Conservation Measures for salmon in Amendment 14 to the Pacific Coast Salmon Plan (Salmon Plan) (PFMC 1999). Freshwater EFH for Pacific salmon in the Central Valley includes waters currently or historically accessible to salmon within the Central Valley ecosystem as described in Myers *et al.* (1998), and includes the San Joaquin Delta hydrologic unit (*i.e.*, number 18040003). Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), Central Valley spring-run Chinook salmon (*O. tshawytscha*), and Central Valley fall-/late fall-run Chinook salmon (*O. tshawytscha*) are species managed under the Salmon Plan that occur in the San Joaquin Delta.

Factors limiting salmon populations in the Delta include periodic reversed flows due to high water exports (drawing juveniles into large diversion pumps), loss of fish into unscreened agricultural diversion, predation by introduced species, and reduction in the quality and quantity of rearing habitat due to channelization, pollution, rip-rapping, etc. (Kondolf *et al.*, 1996a, 1996b; Dettman *et al.* 1987; California Advisory Committee on Salmon and Steelhead Trout 1998).

LIFE HISTORY AND HABITAT REQUIREMENTS

Pacific Salmon:

General life history information for Central Valley Chinook salmon is summarized below. Information on Sacramento River winter-run and Central Valley spring-run Chinook salmon life histories is summarized in the preceding Biological Opinion for the proposed project (Enclosure 1). Further detailed information on Chinook salmon ESUs are available in the NOAA Fisheries status review of Chinook salmon from Washington, Idaho, Oregon, and California (Myers *et al.* 1998), and the NOAA Fisheries proposed rule for listing several ESUs of Chinook salmon (NOAA Fisheries 1998).

Adult Central Valley fall-run Chinook salmon enter the Sacramento and San Joaquin Rivers from July through April and spawn from October through December (FWS 1998). Chinook salmon spawning generally occurs in clean loose gravel in swift, relatively shallow riffles or along the edges of fast runs (NOAA Fisheries 1997).

Egg incubation occurs from October through March (Reynolds *et al.* 1993). Shortly after emergence from their gravel nests, most fry disperse downstream towards the Delta and estuary (Kjelson *et al.* 1982). The remainder of fry hide in the gravel or station in calm, shallow waters with bank cover such as tree roots, logs, and submerged or overhead vegetation. These juveniles feed and grow from January through mid-May, and emigrate to the Delta and estuary from mid-March through mid-June (Lister and Genoe 1970). As they grow, the juveniles associate with coarser substrates along the stream margin or farther from shore (Healey 1991). Along the emigration route, submerged and overhead cover in the form of rocks, aquatic and riparian vegetation, logs, and undercut banks provide habitat for food organisms, shade, and protect juveniles and smolts from predation. These smolts generally spend a very short time in the Delta and estuary before entry into the ocean. Whether entering the Delta or estuary as fry or juveniles, Central Valley Chinook salmon depend on passage through the Sacramento-San Joaquin Delta for access to the ocean.

Starry Flounder:

The starry flounder is a flatfish found throughout the eastern Pacific Ocean, from the Santa Ynez River in California to the Bering and Chukchi Seas in Alaska, and eastwards to Bathurst inlet in Arctic Canada. Adults are found in marine waters to a depth of 375 meters. Spawning takes place during the fall and winter months in marine to polyhaline waters. The adults spawn in shallow coastal waters near river mouths and sloughs, and the juveniles are found almost exclusively in estuaries. The juveniles often migrate up freshwater rivers, but are estuarine dependent. Eggs are broadcast spawned, and the buoyant eggs drift with wind and tidal currents. Juveniles gradually settle to the bottom after undergoing metamorphosis from a pelagic larvae to a demersal juvenile by the end of April. Juveniles feed mainly on small crustaceans, barnacle larvae, cladocerans, clams and dipteran larvae. Juveniles are extremely dependent on the condition of the estuary for their health. Polluted estuaries and wetlands decrease the survival rate for juvenile starry flounder. Juvenile starry flounder also have a tendency to accumulate many of the contaminants in the environment.

English Sole:

The English sole is a flatfish found from Mexico to Alaska. It is the most abundant flatfish in Puget Sound, Washington and is abundant in the San Francisco Bay estuary system. Adults are found in near-shore environments. English sole generally spawn during late fall to early spring at depths of 50 to 70 meters over soft mud bottoms. Eggs are initially buoyant, then begin to sink just prior to hatching. Incubation may last only a couple of days to a week depending on temperature. Newly hatched larvae are bilaterally symmetrical and float near the surface. Wind and tidal currents carry the larvae into bays and estuaries where the larvae undergo metamorphosis into the demersal juvenile. The young depend heavily on the intertidal areas, estuaries and shallow near shore waters for food and shelter. Juvenile English sole feed on small crustaceans such as copepods, amphipods, and on polychaete worms. Polluted estuaries and wetlands decrease the survival rate for juvenile English soles. The juveniles also have a tendency to accumulate many of the contaminants found in their environment which may result in tumors, sores, and reproductive failures.

II. PROPOSED ACTION

The proposed action is described in section II (*Description of the Proposed Action)* of the preceding Biological Opinion for endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon, Central Valley steelhead and critical habitat for winter-run Chinook salmon (Enclosure 1).

III. EFFECTS OF THE PROJECT ACTION

The effects of the proposed action on Sacramento River winter-run and Central Valley spring-run Chinook salmon habitat are described at length in section V (*Effects of the Action*) of the preceding biological opinion, and generally are expected to apply to Central Valley fall-run Chinook salmon, starry flounder, and English sole EFH. Effects on starry flounder EFH may be greater than those for English sole EFH due to the greater usage of freshwater habitat by juvenile starry flounder during the herbicide application period.

IV. CONCLUSION

Based on the best available information, NOAA Fisheries believes that the proposed *Egeria densa* Control Program (EDCP) may adversely affect EFH for Central Valley fall-/late fall-run Chinook salmon, Sacramento River winter-run Chinook salmon, and Central Valley spring-run Chinook salmon managed under the Salmon plan. Likewise, the EDCP may adversely affect EFH for starry flounder and English sole in the action area.

V. EFH CONSERVATION RECOMMENDATIONS

The habitat requirements for Central Valley fall-/late fall-run Chinook salmon within the action area are similar to those of the Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon and Central Valley steelhead addressed in the preceding Biological Opinion (Enclosure 1). Therefore, NOAA Fisheries recommends that the terms and conditions 1a-b, 1d-e, and 2a-d from the biological opinion be adopted as EFH Conservation Recommendations for EFH in the action area. In addition, other conservation measures may be implemented in the project area, as addressed in Appendix A of Amendment 14 to the Pacific Coast Salmon Plan (PFMC 1999) where applicable to the authority of the USDA-ARS and the DBW. Starry flounder and English sole EFH may be protected by following the conservation recommendations for Pacific salmon EFH in addition to the following recommendations:

1. Minimize the application of herbicides in waters that serve as rearing habitat for juvenile flatfish in the Delta,

2. Minimize the disturbance of benthic substrate in areas of shallow water used by flatfish for foraging; and

3. Avoid degradation of native emergent and submerged vegetation in marshes and submerged tidal flats in areas utilized by juvenile flatfish for rearing and foraging.

VI. STATUTORY REQUIREMENTS

Section 305 (b) 4(B) of the MSA requires that the federal lead agency provide NOAA Fisheries with a detailed written response within 30 days, and 10 days in advance of any action, to the EFH conservation recommendations, including a description of measures adopted by the lead agency for avoiding, minimizing, or mitigating the impact of the project on EFH (50 CFR § 600.920[j]). In the case of a response that is inconsistent with our recommendations, the USDA-ARS must explain its reasons for not following the recommendations, including the scientific justification for any disagreement with NOAA Fisheries over the anticipated effects of the proposed action and the measures needed to avoid, minimize, or mitigate such effects.

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